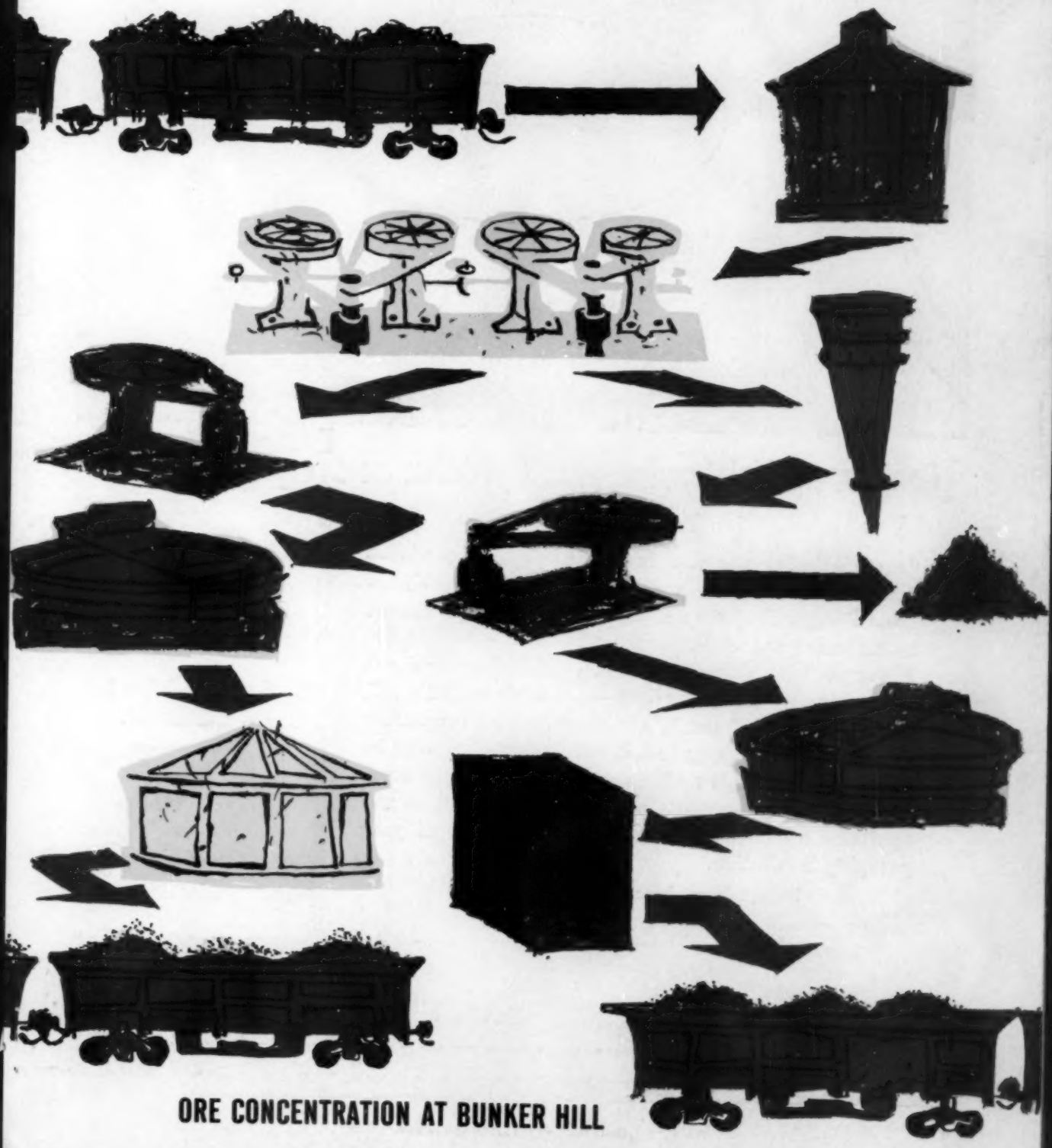
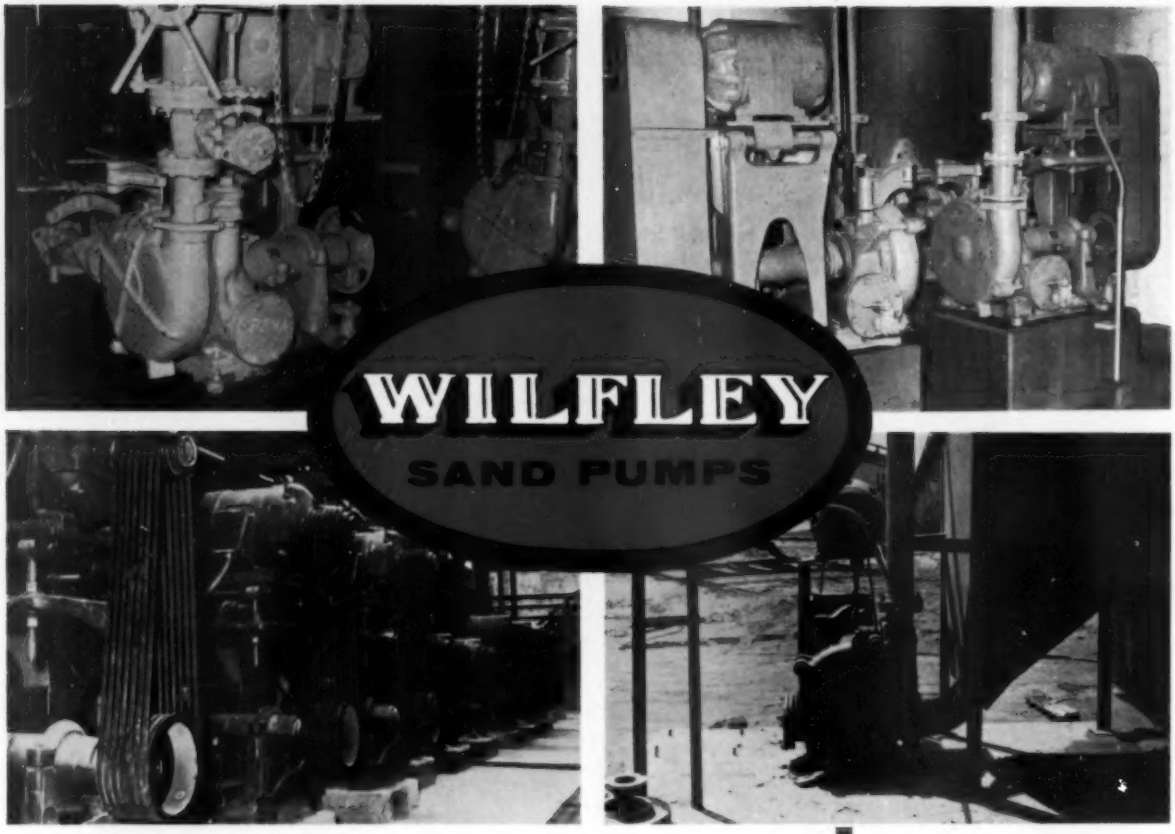
MINING engineering

JUNE 1961



ORE CONCENTRATION AT BUNKER HILL



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COMING EVENTS

June 12-July 21, Eleventh Annual Short Course in Coal Preparation, West Virginia University School of Mines, Morgantown, W. Va.

June 18-23, Summer General Meeting of AIEE, Campus of Cornell University, Ithaca, N. Y.

June 25-28, Annual Meeting, Rocky Mt. Coal Mining Institute, Hotel Colorado, Glenwood Springs, Colo.

June 26, 64th Annual Meeting of ASTM, Chalfonte-Haddon Hall, Atlantic City, N. J. Bruce Chalmers, AIME, will present the annual Edgar Marburg Lecture in the afternoon.

June 28-30, ASME—University of Colorado Joint Automatic Control Conference, University of Colorado, Boulder, Colo.

July 4-7, 27th Annual Meeting of The National Society of Professional Engineers, Olympic Hotel, Seattle, Wash.

July 27-29, Seventh Annual Institute, Rocky Mountain Mineral Law Foundation, Albuquerque, N. M.

Aug. 28-Sept. 1, ASME—University of Colorado International Heat Transfer Conference, University of Colorado, Boulder, Colo.

Sept. 11-14, American Mining Congress Metal Mining—Industrial Minerals Convention, Seattle, Wash.

Sept. 14-15, ASME-AIEE Engineering Management Conference, Roosevelt Hotel, New York City.

Sept. 17-20, Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A., sponsored by AIME: Society of Mining Engineers' Minerals Beneficiation Division, Brown Palace and Cosmopolitan Hotels, Denver.

Oct. 2-3, Joint Meeting, Industrial Minerals Division of SME of AIME—CIM, Ottawa.

Oct. 3-4, Southern Research Institute, Birmingham.

Oct. 5-7, AIME-ASME Joint Solid Fuels Conference, Birmingham.

Oct. 18-21, AAPG Mid-Continent Regional Meeting, Amarillo, Texas.

Oct. 25-27, 11th Annual Meeting Gulf Coast Assn. of Geological Societies, Granada Hotel, San Antonia, Texas.

Nov. 1-3, Southwestern Federation of Geological Societies Fourth Annual Meeting, El Paso, Texas.

Nov. 3-4, Joint Meeting Central Appalachian Section, AIME and the West Virginia Coal Mining Institute, The Greenbrier, White Sulpher Springs, W. Va.

Nov. 3, Pittsburgh Sections of AIME and NOHC Off-the-Record Meeting, Penn-Sheraton Hotel, Pittsburgh.

Nov. 5-9, 31st Annual International Meeting of the Society of Exploration Geophysicists, Denver.

Dec. 4, Annual Meeting Arizona Section of AIME, Pioneer Hotel, Tucson, Ariz.

Dec. 6-8, Nineteenth Electric Furnace Conference, sponsored by the Metallurgical Society of AIME. Penn-Sheraton Hotel, Pittsburgh.

Feb. 6-22, 1962, AIME Annual Meeting, New York City.

Apr. 23-25, 12th Annual Meeting, Rocky Mt. Section, AAPG, Salt Lake City.

Apr. 26-28, AIME Pacific Northwest Metals and Minerals Conference, Ben Franklin Hotel, Seattle, Wash.

May 7-9, American Mining Congress Coal Convention, Pittsburgh.

MINING engineering

VOL. 13 NO. 6 **JUNE 1961**

COVER *At the present time 2300 tons of lead-zinc ore is processed daily at Bunker Hill Co.'s operation at Kellogg, Idaho. The path followed by the run-of-mine ore in this plant has been symbolized by cover artist Herb McClure, but the story of this concentrator begins on page 573.*

ARTICLES

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578 **Marginal Analysis—Its Application in Determining Cut-Off Grade** • *E. L. Vickers*

583 **Ground Support at the Pitch Mine** • *J. E. Dunn*

587 **Electronic Computations of Open Pit Tonnage and Ore Grade** • *R. L. Wilson*

592 **Transporting Open Pit Production by Combination Surface—Underground Haulage** • *E. P. Pfleider and C. A. Dufresne*

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ABC

MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed on the *Drift* page.

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This service, which cooperates with the national societies of Civil, Chemical, Electrical, Mechanical, Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or non-members, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number. When making application for a position include 8¢ in stamps for forwarding application. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance. Local offices of the Personnel Service are at 8 W. 40 St., **New York 18;** 57 Post St., **San Francisco;** 29 E. Madison St., **Chicago 1.**

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One to five years experience; preferably in milling or research. Work in head office of mining supplier, New York area.
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General Mine Superintendent B.S. Degree Mining Engineering. Five-Ten years supervisory experience in all phases of mining including flotation. Dragline experience helpful. Will plan and direct extensive phosphate mine operation in Florida. Will report to the Works Manager. Permanent job.

Mill Superintendent B.S. degree Metallurgical Engineering. Five-Ten years experience in mineral beneficiation. Supervisory experience necessary. Will report to General Mine Superintendent of phosphate mine operations in Florida. Permanent job.

These positions are enhanced by generous fringe benefits such as paid hospitalization, vacations, sick leave, etc. Salaries are open.

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350 Hurt Building Atlanta, Georgia

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above.

MEN AVAILABLE

Mining Engineer, graduate, age 45. Twelve years in all phases exploration, mine engineering, mine operation, open pit or underground. Presently employed. Good health. Location immaterial. M-611.

Manager, Superintendent or Sales Engineer. Thirty years experience mining, milling metallic and non-metallic ores, heavy chemicals, and open pit mining. Ten years in Latin America. Plant layout, startup, operation, and trouble-shooting. Extensive travel satisfactory. Salary with participation desired. West or Latin America preferred but will consider any location. M-612.

Manager or Production Engineer, University of Arizona, B.S. in mining engineering. Ten years experience underground engineering and supervisory capacities in gold, copper, and Ag-Pb-Zn mines; seven years open pit aluminum and Ni-Co projects as engineer-in-charge. Prefer West. M-613.

Attorney-Geological Engineer, age 34. Six years underground experience as mining engineer and geologist with major mining company; three years diversified legal experience in civil and criminal litigation; trial work and briefing for District and Appelate courts. Desire position on legal staff or as administrative assistant to vice president. M-614.

Manager or Senior Engineer, B.S. Ch.E. Twenty years with major base metals producers at all levels from laborer to production supervision and research director. Seven years with leading firm of consulting and design engineers, to manage metallurgical engineering. Prefer U.S. or Canada. M-615.

Engineer, Mining-Petroleum, Geophysicist, Geologist, B.S. E.M., M.S., Ph.D., physics-geology. Experienced in organization and direction of exploration department: planning, programming, cost estimating, supervision, interpretation airborne and ground geophysical surveys in minerals and petroleum on all continents. Any location. M-616.

Engineer-Geologist, B.S. and M.S. in geology, one year research toward PhD., age 45. Fifteen years experience U.S. and Far East in minerals exploration in a wide variety of deposits both metallic and nonmetallic. Qualified for engineering geology assignments, foundation investigations, aggregate sources, etc. Any location. M-2156-Chicago.

Superintendent-Mining Engineer, B.S. in mining geology, age 58. Broad experience in exploration, development, and operation. Good cost record. Good health. M-2157-Chicago.

Geologist-Geophysicist, B.A. in geology, with a minor in math and physics, age 32. Ten years mining geology and geophysical exploration. Familiar with all phases and types of exploration drilling. Experience in property evaluation and estimating. Supervision of drilling and geophysical exploration programs. Any location in U.S. except South. M-2158-Chicago.

Mining Engineer, Geologist, geological engineering, age 32. Four years experience in progress of mining, grade of rock removed, supervision of three man party mapping, drafting, calculations, guiding drilling operations, laid out tailings pond and pumphouse buildings for underground zinc mine. Prefer Southwest U.S. Home: California. $575. Se-1150.

Exploration, Development Engineer, mining engineering, age 51. Four years experience including mineral prospecting, exploration, property evaluation, title studies, cost estimating, mine development, construction contracts, design engineering, purchasing of equipment, machinery for mines and mills. Prefer California. Home: California. $900. Se-1223.

Mine Superintendent, age 53. Over 30 years experience from miner to superintendent and consulting work including evaluation of mineral deposits, airborne magnetometer surveys, establish work norms, incentive pay schedules, design and install ore handling facilities underground and surface. Prefer foreign location. Home: Washington. $12,000. Se-1225.

Geologist Mine, age 31. Six years diversified engineering and mining geology experience in nonmetallic and iron. Speak, read, and write Spanish. Prefer Southwest U.S. or Latin America. Home: California. Se-1235.

Junior Mine Engineer, mining engineering, age 26. Experienced as miner, supervisor and engineer in mining industry. Know production methods—particularly open pit. Prefer far western U.S. Home: Arizona. Se-1261.

Geologist, mining engineer, age 35. Ten years experience in mining including originating site location, investigation and mining method design, specification writing, client conferences, development and stoping plans, ore reserve estimations, mapping, and photogrammetry. Any location. Home: California. Se-1304.

Mine Superintendent, Geologist, geological engineering, age 37. Over 12 years mining experience including mine superintendent, supervision mining, 500 tpd underground, coordination of mining, engineering, and geology exploration in western states. Prefer West. Home: Colorado. $800. Se-1320.

Geologist, Mine, age 37. Ten years experience in West in many phases of geological exploration including studies for metallic and nonmetallic deposits, exploration for base metal deposits, supervision of diamond drills and churn drill on exploration, mapping, and setting up geologic program for operation of open pit mine, surveying, drill hole layout and ore reserve work. Prefer western U.S. Home: Nevada. $850. Se-1337.

Mining Geologist, age 25. Underground experience, supervised drill crews, geochemistry and geological mapping. Any location. Home: California. $550. Se-1335.

Geologist, age 27. Three years experience in base metal exploration, planning, mobilization, and supervision of field projects in Northwest and Alaska, including drilling, sampling, mapping, photo interpretation, trace element research, geophysical and geochemical surveys. Any location. Home: Washington. Se-1369.

Chief Mining Engineer, age 24. Over two years experience in open pit and underground mining including mapping, design, layout of installations, ore reserve studies, time studies, safety lectures, mining systems layout stopes, drifts, sampling all working places. Prefer Intermountain west. Home: California. $800. Se-1380.

Geologist, age 31. Experienced in geological mapping, surface and underground diamond drill supervision and development of property from raw prospect to underground exploration stage. Prefer western U.S. Home: California. $550. Se-1398.

POSITIONS OPEN

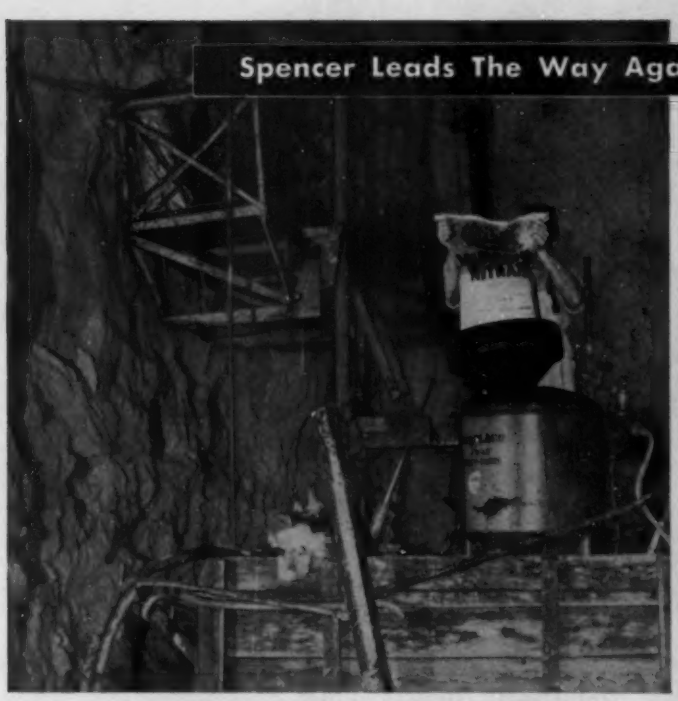
Assistant Chief Engineer, mining engineering graduate, with open pit iron ore experience, including construction and operation of washing plant. Housing accommodations available late 1962. $10,200 year. Africa. F238.

Mining Superintendent, graduate, with several years underground mining experience and some milling desirable for small mercury mine in Colombia, S.A. Must speak Spanish and accept single status. $8400 plus board and meals. F174.

Recent Graduate Mining Engineer or Geologist for junior gold mining position, including surveying, some geology, melting and assaying of gold. Some work on gold dredges. Some knowledge of Spanish desirable. $350 month basis and will receive three months additional each year. South America. F136.

Mining Engineer, graduate, to assist mine superintendent in all phases of open pit mining operations. Will consider inexperienced

(Continued on page 539)



A two-man team makes short work of filling blast holes with a Spencer Powder Monkey pneumatic machine and Spencer N-IV Ammonium Nitrate and fuel oil mixture. This is the fastest, most economical loading method known.

No tamping required! Spencer N-IV and fuel oil compound loaded with a pneumatic machine completely fills the holes to the proper density for maximum blast efficiency.

Now Spencer N-IV Goes Underground . . . Cuts Explosive Costs 40% to 50%

Leading the way to lower costs in underground blasting, Spencer's technical experts began more than three years ago to pioneer the use of Spencer N-IV Ammonium Nitrate and fuel oil mixtures in sub-surface mines. Today, Spencer N-IV is being successfully used in many underground mining operations.

The successful application of an ammonium nitrate and fuel oil mixture in underground blasting depends on:

a. A special grade ammonium nitrate such as Spencer N-IV.

b. The technical service experience of Spencer personnel who have handled millions of pounds of N-IV in underground mining.

Spencer N-IV should be used only in underground blasting applications such as limestone, salt, potash, granite, iron ore, gypsum, copper and uranium. This ammonium nitrate and fuel oil blasting agent is in no way to be construed as a permissible and is not to be used in underground coal mining.

Here are some of the important advantages of using Spencer N-IV Ammonium Nitrate and fuel oil in underground mining:

1. Explosive costs are reduced 40% to 50% when Spencer N-IV and fuel oil mixture is used instead of dynamite. Compared on a pound for pound basis with dynamite, Spencer N-IV produces at least equivalent performance, yet the per pound price of Spencer N-IV is far less.

2. Drilling costs are lowered because Spencer N-IV provides reliable blasting in small diameter holes where formerly dynamite was required. The uniform, round prills of Spencer N-IV flow freely to permit ideal loading density in holes as small as 1⅜ inches in diameter.

3. Faster, more economical loading is achieved by using Spencer N-IV to fill horizontal blast holes with a pneumatic loading machine — such as the Spencer Powder Monkey. For example, where this advanced loading method is being used, operators report that more than 250 holes can be filled and blasted in a regular eight-hour shift. More than 40 Spencer Powder Monkeys are presently in operation in underground mines.

4. Fragmentation is excellent — using Spencer N-IV for underground blasting, experience indicates that fragmentation results are equal or superior to those produced by dynamite.

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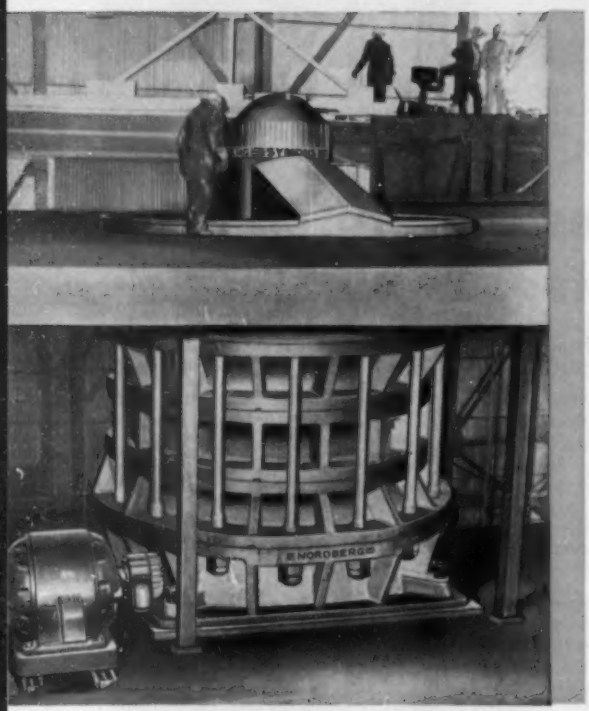


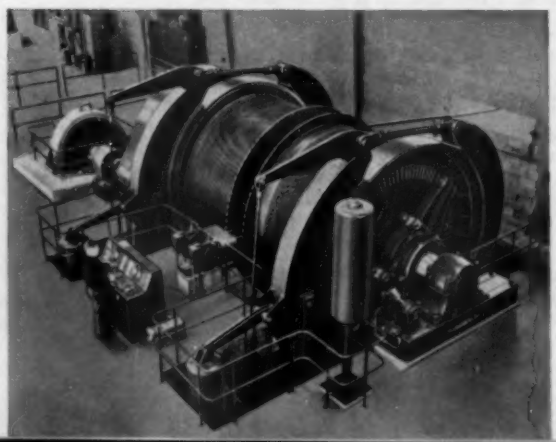
FOR PRIMARY CRUSHING OF MOLYBDENUM

This 60″ Symons Primary Gyratory Crusher has seen several years of service in the primary breaking of "moly" ores in Colorado. Other heavy duty Symons Gyratory Crushers are built with 30″, 42″, 48″, 54″ and 72″ feed opening widths and for capacities to 3500 or more tons per hour.

Your interest in lowering the cost, improving the quality, and raising the production of metallic and non-metallic ores and industrial minerals is a mutual interest which Nordberg has shared with the mining industry for 75 years.

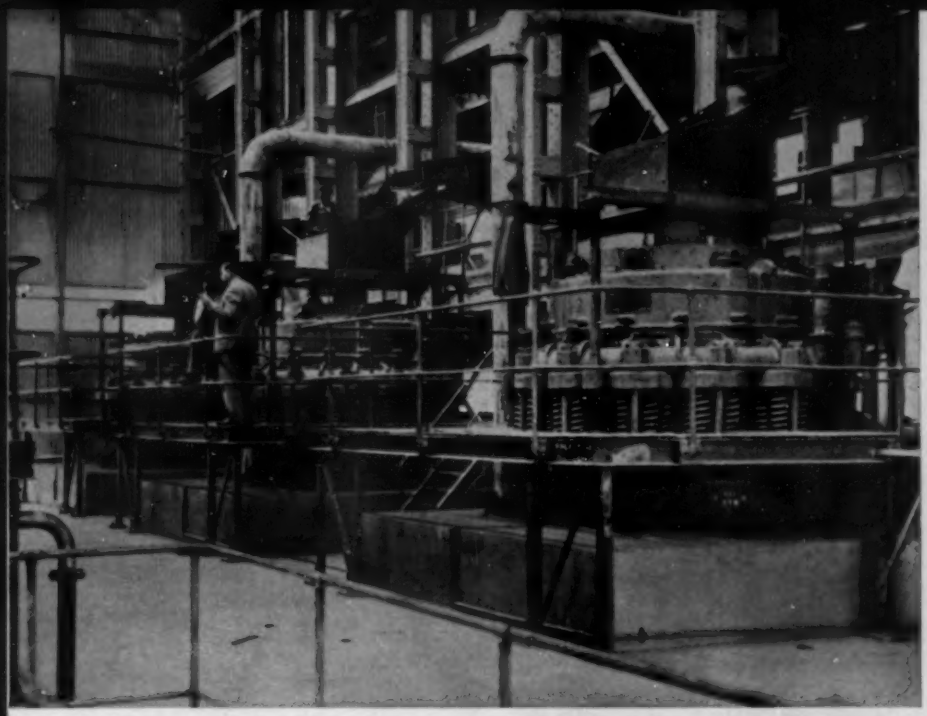
This common interest and the many years of broad, yet intimate experience with the mining fraternity is reflected in the effectiveness and quality of Nordberg mining machinery. It is because of this background that Nordberg continues to lead in the design and construction of mining machinery which is *consistently first choice of the world's leading ore and mineral producers.*

SYMONS . . . a registered Nordberg trademark known throughout the world.



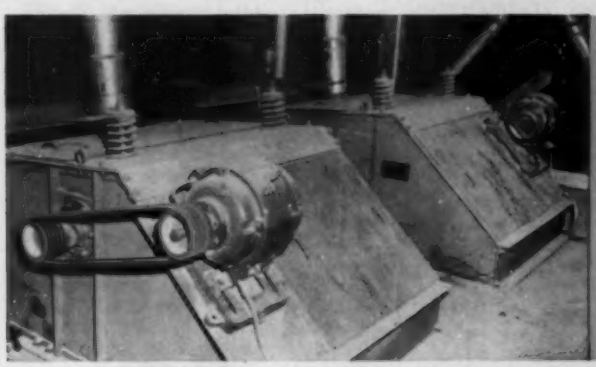
FOR HOISTING IRON ORE

Nordberg Mine Hoists for men and material are built in both conventional drum types as well as friction types . . . for push-button semi-automatic, fully automatic or manual control. Shown is a typical conventional double drum hoist.



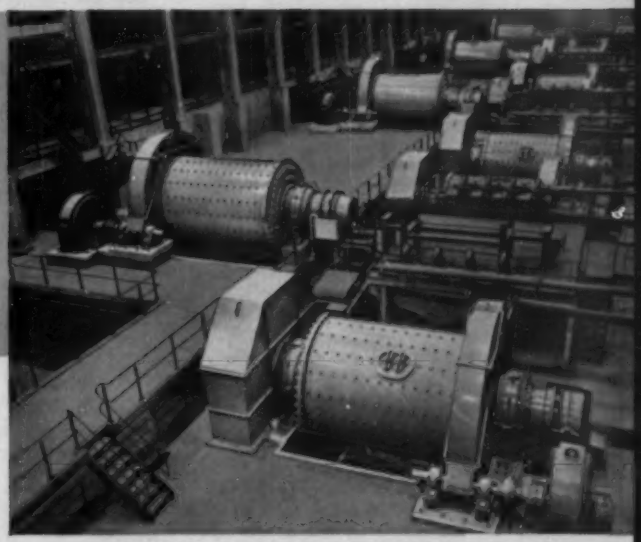
FOR FINE REDUCTION CRUSHING OF COPPER

These three Symons Cone Crushers are serving a Northern Rhodesian copper mine installation. Used for low cost, continuous production of quality products, Symons Cones are first choice of major producers the world over, in capacities to over 1500 tons per hour.



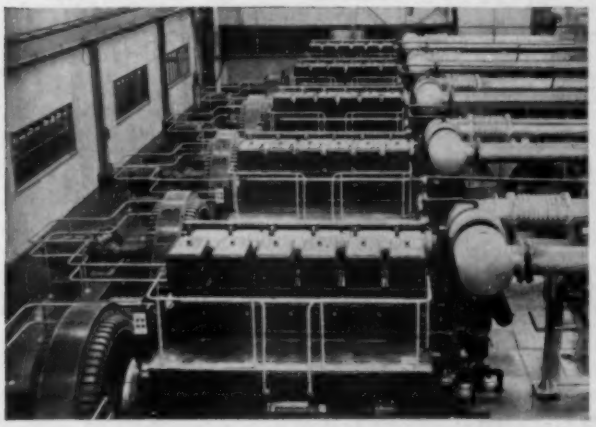
FOR SCREENING URANIUM ORE

These two 4′ x 8′ Symons Rod Deck Screens serve a large uranium processing operation in Canada. Other Symons Vibrating Screens are built in a wide range of types and sizes to handle numerous ore and mineral separation jobs from scalping to fine screening.



FOR GRINDING TACONITE

Shown are but a few of the many Nordberg Grinding Mills being used to reduce hard, abrasive taconite iron ore to the fineness of flour. Nordberg mills include Rod, Ball, Pebble, Tube and Compartment types, in sizes to 13′ in diameter and up to 50′ in length.



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Nordberg 2-cycle and 4-cycle diesel, Duafuel®, and spark-ignition gas engines are reliably serving the mining industry in many parts of the world. Sizes range from 10 to over 12,000 hp in a single engine.

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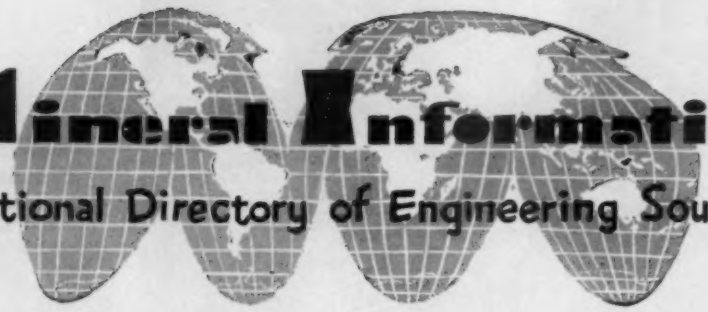
For further information, circle the following numbers on the reader service card: 3, Primary Crushers; 55, Hoists; 56, Symons Cone; 57, Screens; 58, Grinding Mills; 59, Diesels.

M161-R



Mineral Information

An International Directory of Engineering Source Material

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Analogue Computation, 4 Vol., by Stanley Fifer, *McGraw-Hill Book Co. Inc.*, 1961, 1331 pp., $39.50—This four-volume work has continuous page and chapter numbering, with the Table of Contents in Volume 1 only and indexes in Volume 4 only. It is intended for the embryonic and practicing mathematician, physicist, or engineer. The first two volumes are devoted primarily to the general-purpose d.c. (direct current) functional computer, the principal element of which is the d-c (direct-coupled) feedback amplifier, and they form a basic course in analogue computation. The term "functional computer" denotes that each of its components performs one or more distinct mathematical operations. This is in contract to the "direct analogue computer" described in volume three and four (intended for an advanced course), in which there is generally a one-to-one correspondence between the parameters and the variables of the given system and those of the computer mechanization. Some of the special topics covered in this work are Fourier analysis, the potential analogue, the secular, polynomial, and differential equations, automatic, static, and dynamic checking system, and applications of computers to automation. • • •

Rare-Earth Elements by D.I. Ryabchikov, available from *Office of Technical Services*, U.S. Dept. of Commerce, Washington 25, D. C., 1959, 356 pp., $3.75—This translation of the 1959 USSR Academy of Sciences text is published for the N.S.F. and the U.S. Department of Commerce by the Israel Program for Scientific Translations. It contains 42 papers by Soviet specialists dealing with the production, properties, geochemistry, determination and analysis, and applications of various rare-earth elements. There are papers on general methods and techniques for use with rare-earth elements, as well as papers on particular elements including apatites, cerium, yttrium, Trilon A and B, and europium among others. Applications of various elements in the glass industry, chemistry, and for alloying magnesium cast alloys, are described.

Kempe's Engineers Yearbook for 1961, 2 Vol., 66th Edition edited by C. E. Procter, *Morgan Bros. (Publishers) Ltd.*, 28 Essex St., Strand, London W.C. 2, Eng., 1961, approx. $12.25 (87s 6d.)—This compendium of modern practice in the fields of civil, mechanical, electrical, marine, gas, aeronautical, mining, and metallurgical engineering contains revised information in almost every one of its 84 sections. It is a useful compilation with an extensive index in Volume 2. Its wide coverage lessens its specificity, thus making it more useful for general reference than for the specialist. Although of British origin, its careful attention to other national standards and units makes it of universal application.

Mathematical Handbook for Scientists and Engineers by Granino A. Korn and Theresa M. Korn, *McGraw-Hill Book Co. Inc.*, 1961, 943 pp., $20.00—This is a comprehensive reference collection of mathematical definitions, theorems, and formulas for scientists, engineers, and students (including both undergraduate and graduate level material). Proofs are omitted, and related formulas are presented in concise tables, enabling compact treatment and a special arrangement of topics. This special arrangement, within each chapter, is such that a connected review of each subject is accomplished. Numerous references are given to provide access to other material for more detailed studies. Six appendices contain numerical tables, tables of integrals and Fourier expansions, and other such useful data. • • •

The Complete Scientist, a report by the Leverhulme Study Group, *Oxford University Press*, 1961, 162 pp., $2.90—As the subtitle indicates, this report is "An enquiry into the problem of achieving breadth in the education at school and university of scientists, engineers, and other technologists." The report was made to the British Association for the Advancement of Science. It reviews for the first time and considers as a whole the successive stages in the education of the would-be graduate scientist or engineer from elementary school to the post-graduate course. "It will make a significant contribution to the problem of giving adequate weight to non-scientific subjects in the education of these students . . .," states Sir George Thomson, President of the BAAS in the Preface. • • •

Annual Review in Automatic Programming, Vol. 1, edited by Richard Goodman, *Pergamon Press*, 122 E. 55th St., New York 22, N.Y., 1960, 300 pp., $10.00—This first volume of a proposed series of annual reviews contains the 18 papers presented at the Conference on Automatic Programming of Digital Computers held at Brighton Technical College (England) in April, 1959. Most of the papers have been modified to deal with points made in discussion. Constituting a review of work being done in this field, particularly in Britain, the papers discuss such topics as future trends, autocades, interpretative and translating programs, special automatic programming systems, and the philosophy of programming. Also included are the two pioneer papers on computable numbers by A. M. Turing, enunciating the fundamental theory on which automatic programming is based. • • •

Cobalt Monograph, edited by the staff of the Centre d'Information du Cobalt, *M. Weissenbruch, S.A.*, 49 rue du Poincon, Brussels, Belgium, 1961, 515 pp., $15.00 (750 francs)—This reference source, in English, presents available data on the physical, chemical, and mechanical properties of the element, provides detailed studies of the alloy systems, and reviews present and potential applications. Some of the topics covered are history, mining, extractive metallurgy, economics, magnetic materials, and cemented carbides. The volume includes 185 figures, 105 tables, and a comprehensive bibliography through 1958. Among the contributors were 34 staff members of Battelle Memorial Institute.

Summary of Mining and Petroleum Laws of the World by Northcutt Ely, **Bureau of Mines I.C. 8017,** *Superintendent of Documents,* Washington 25, D.C., 1961, 215 pp., $1.00—This guide to mining and petroleum laws of the world—the first of its kind ever published in a single volume—presents highlights of mining and mineral land tenure laws of more than 100 countries. The material is listed in an easy-to-find manner and includes references to sources of basic information for the reader who wishes to obtain other facts about a particular country. Except for some of the smaller nations of the free world whose mineral resources are meager, all nations having laws permitting private ownership and development of mineral rights are listed alphabetically within one of nine chapters, grouped by continents.

Scandinavian Research Guide, 2 Vol., *Scandinavia Council for Applied Research,* available from National Academy of Science, National Research Council, 2101 Constitution Ave., Washington 25, D.C., $10.00—This guide is a directory of research institutions within technology and science exclusive of life sciences which gives concise, detailed, and factual information on more than 1500 research institutions in Scandinavia. The information includes the name, address, and telephone number for each institution; name of the head; number of staff; activities; policy concerning contracts; and serial publications. Volume 1 is devoted to research institutes and Volume 2 includes central research organizations, universities and institutes of technology, information centers, scientific societies, and indexes.

Drilling and Blasting Symposium, *Quarterly of the Colorado School of Mines,* Golden, Colo. 1961, $5.00—This volume of the Quarterly contains the papers and discussions from the Tenth Annual Drilling and Blasting Symposium held at the Colorado School of Mines, Oct. 16 to 19, 1960. Each of the four technical sessions is treated in a separate part. Part V contains a summary by John J. Reed and John S. Rinehart. For some idea of the material covered see pp. 1183 and 1184 in the November 1960 issue of MINING ENGINEERING.

1960 Supplements to Book of ASTM Standards: Part 1 Ferrous Metals Specifications, *American Society for Testing Materials,* 1916 Race St., Philadelphia 3, Pa., 1961, 444 pp., $4.00—Includes 63 standards on steel pipe, tubes, castings, bolting materials, boiler plates and rivets, sheet and strip, bars, forgings, chain, corrosion and heat-resisting steels. Also structural and rivet steel, coated steel and iron products, wrought iron, cast iron, ferro-alloys, titanium alloys, zinc coated steel, metal powder products and steel rails. These standards bring up-to-date the 1958 Book of Standards and the 1959 Supplement as they represent either new standards or revisions adopted in 1960. **Part 2, Nonferrous Metals Specifications and Electronic Materials,** 348 pp., $4.00—Includes 57 standards for copper and copper-base alloys, ingot, plate, sheet, strip, rolled bar, etc. Also solder metal, zirconium, lithium, materials for electron tubes and semi-conductor devices, metal powders and electro-deposited metallic coatings. In addition there are standards for die-cast metals, aluminum and aluminum alloys, magnesium and magnesium alloys, and metallic electrical conductors. **Part 3, Methods of Testing Metals (Except Chemical Analysis),** 180 pp., $4.00—Includes 19 standards for tests for mechanical properties, effect of temperature, dosimetry, electrical and magnetic properties. Also included are nondestructive testing metallographic tests, and tests for metal powders.

• • •

Der Deutsche Steinkohlenbergbau, Vol. 4: Aufbereitung der Steinkohle, Part 1, *Verlag Glückauf GmbH,* Essen, Germany, 1960, 407 pp., no price given—Part 1 of the fourth volume of this extensive treatise on coal deals with preparations, including basic theory, classification, and separation. About three-fourths of the book is devoted to the latter, with all the major processes—dry, wet, and upwash, flotation, electrostatic and Convertrol, etc. covered.

• • •

Le Probleme Du Broyage Et Son Evolution by Roger Guillot, *Editions Eyrolles,* Paris, France, 1960, 186 pp., approx. $6.00 (NF 29.35)—Prepared under the auspices of the Association Nationale de la Recherche Technique, this study investigates the various problems related to comminution. The first chapter deals with methods, discussing terminology, classification, the latest developments in crushing-mills, and various studies related to critical speeds and vibratory systems in crushing-mills, and various studies related to critical speeds and vibratory systems in crushing processes. Chapter 2 describes the qualitative and quantitative aspects of the crushability of materials, including descriptions of the relevant crushability indices. The third chapter discusses both conventional and recent theories and findings connected with mechanical comminution and related formulas. The final chapter deals with the breakage process itself and the surface energy involved in mechanical comminution, and presents the author's conclusions and recommendations. The rest (fully half) of the book contains a digest of important papers by various authorities discussing the topics covered in the preceding chapters.

(Continued on page 533)

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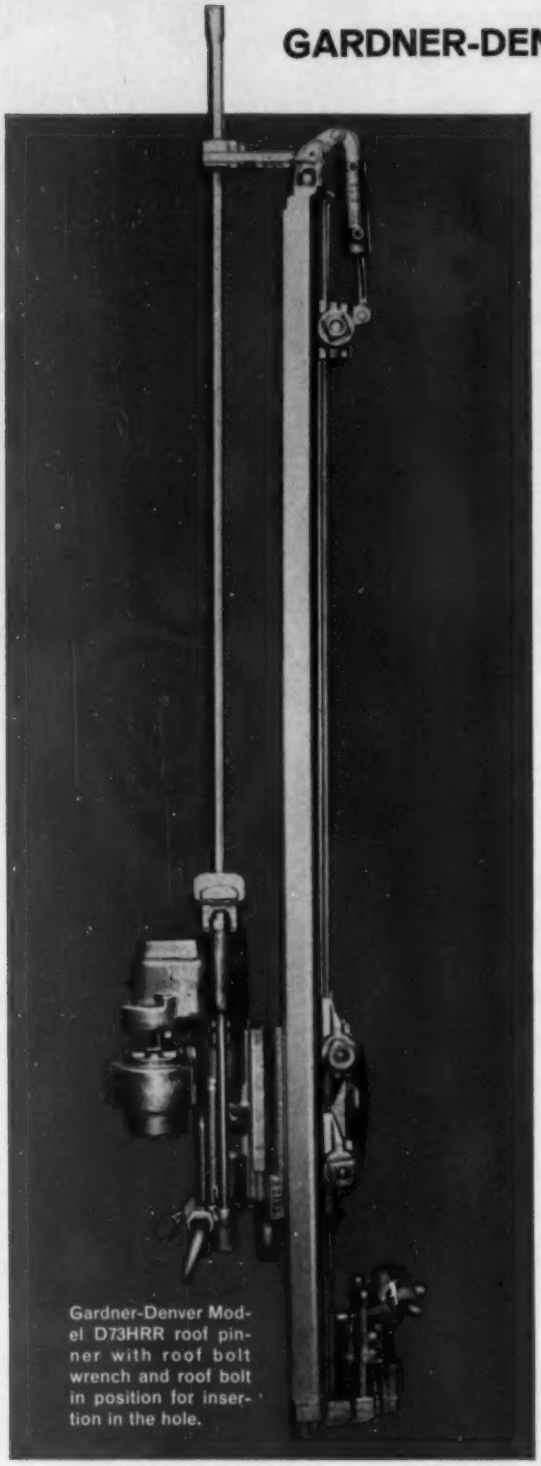

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BOOKS

(Continued from page 531)

STATE PUBLICATIONS

North Dakota

Geological Survey
University Station
Grand Forks, N. D.

Summary of the Stekoll Petroleum Corp., John Johnson No. 1, Bottineau County, well No. 2128, permit No. 2137, Circ. 239, 1960, gratis.
First Supplement to Well Samples Available for Study at the North Dakota Geological Survey Grand Forks, North Dakota, 1960, gratis.
Second Supplement to Well Samples Available for Study at the North Dakota Geological Survey Grand Forks, North Dakota, 1960, gratis.
Second Supplement to Cores Available Study at the North Dakota Geological Survey Grand Forks, North Dakota, 1960, gratis.

Ohio

Dept. of Natural Resources
Div. of Geological Survey
Orton Hall, Ohio State University
Columbus, Ohio

Coal Resources of the Upper Part of the Monongahela Formation and the Dunkard Group in Ohio, R.I. 38, 1960, 50¢.
Coal Resources of Ohio Bull. 58, 1960, $2.00.

Pennsylvania

Order From:
Topographic & Geological Survey
Dept. of Internal Affairs
Harrisburg, Pa.

List of Geological Publications, 1960, gratis.

Order From:
Div. of Documents
10th & Market Streets
Harrisburg, Pa.

Geologic Map of Pennsylvania, 1960 edition, $3.75.

Tennessee

Div. of Geology
G-5 State Office Bldg.
Nashville 3, Tenn.

The Marble Industry of Tennessee, Inf. Circ. 9, 1960, 50¢.
The High-Silica Resources of Tennessee, R.I. 10, 1960, $1.00.
Lake City Geologic Map, GM 137-NW. 1960, 50¢.
Rockwood Geologic Map, GM 123-SW, 1960, 50¢.
Jacksboro Geologic Map, GM 136-SW, 1960, 50¢.

Texas

Bureau of Economic Geology
The University of Texas University Station
Box 8022
Austin 12, Texas

Aspects of the Geology of Texas: A Symposium, Publication 6017, 1960, $2.00.
Stratigraphy of the Black Ranch-Crystal Falls Section (Upper Pennsylvania), Northern Stephens County, Texas, R.I. 41, 1960, $1.25.

Virginia

Dept. of Conservation and Economic Development
Div. of Mineral Resources
Box 3667, University Station
Charlottesville, Va.

Sources of Aggregate Used in Virginia Highway Construction, Mineral Resources Report 1, 1960, 75¢.

Geology and Ground-Water Resources of Pittsylvania and Halifax Counties, Bull. 75, 1960, $1.25.

Washington

Dept. of Conservation
335 General Administration Bldg.
Olympia, Wash.

Geological Interpretation of Airborne Magnetometer and Scintillometer Survey, Mt. Bonaparte, Bodie Mountain, Curley, Aeneas, and Republic Quadrangles, Okanogan and Ferry Counties, Washington, R.I. 20, 1960, $1.50.
Bibliography and Index of the Geology and Mineral Resources of Washington 1937-1956, Bull. 46, 1960, $2.00.

West Virginia

Geological and Economic Survey
Morgantown, W. Va.

A Guide to the Common Fossil Plants of West Virginia, Educational Series, 1960, 50¢ plus 9¢ postage.
A Symposium on the Sandhill Deep Well, Wood County, West Virginia, R.I. 18, 1959, $1.50 plus 9¢ postage.
Photogeologic Techniques Applied to the Mapping of Rock Joints, R.I. 19, 1960, 50¢ plus 5¢ postage.
Water Resources of Kanawha County, West Virginia, Bull. 20, 1960, $2.00 plus 9¢ postage.

Wisconsin

Geological and Natural History Survey
Soil Survey Division
204 Soils Bldg.
University of Wisconsin
Madison, Wis.

Soil Survey of Oneida County, Wisconsin, Bull. 62, Soil Series No. 57, 1959, $1.25.

FOREIGN PUBLICATIONS

Australia

Dept. of National Development
Bureau of Mineral Resources, Geology, and Geophysics
Box 378
Cubberra City, N.S.W.

Mineral Resources of Australia—Clay, Summary Report 28, 1959, approx. 56¢ (5s.).
Mineral Resources of Australia—Silver, Summary Report 37, 1959, approx. 56¢ (5s.).
Mineral resources of Australia—Gemstones, Summary Report 43, 1959, approx. 56¢ (5s.).
The Australian Mineral Industry 1958 Review, 1959, approx. $1.20 (12s.).
The Australian Mineral Industry 1959 Review, 1960, approx. $2.24 (20s.).
Devonian Brachiopods from the Fitzroy Basin, Western Australia, Bull. 45, 1960, approx. $2.24 (1).
A Contribution to the Geology and Glaciology of the Western Part of Australian Antarctic Territory, Bull. 52, 1960, approx. $2.24 (1).
Devonian and Carboniferous Brachiopods from North-Western Australia, Bull. 55, 1960, approx. 56¢ (5s.).
The 1951 Eruption of Mt. Lamington, Papua, Bull. 38, 1959, gratis.

New South Wales

The Geological Survey
Dept. of Mines
P. O. Box 48
Sydney, N.S.W.

Technical Reports, Vol. 4, 1956, approx. $1.57 (£1 18s) plus approx. 22¢ postage (3s. 2d.).

South Australia

Dept. of Mines
Box 38, Rundle St. P. O.
Adelaide, South Australia

Bibliography of South Australian Geology, 1959, approx. 56¢ (5s.).

(Continued on page 535)

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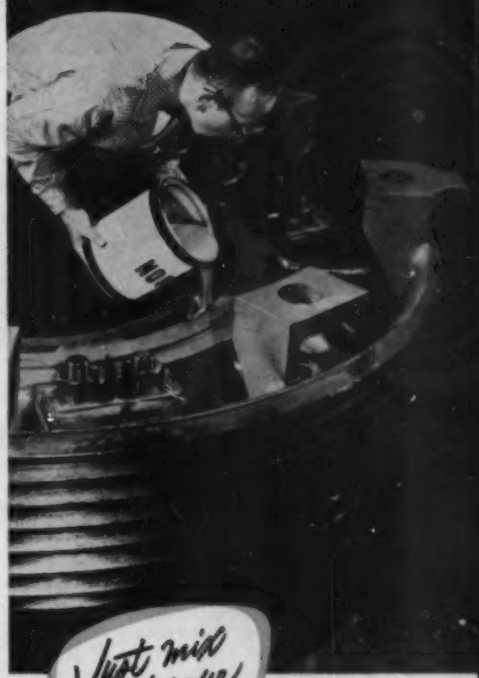

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AIME TRANSACTIONS (MINING)

Volume 220, 1961

As Transactions papers are accepted for the forthcoming volume, the titles and abstracts will be published in MINING ENGINEERING. The continuing list appears below. Watch for additional announcements which will be listed on the "Contents" and "SME Bulletin Board" pages in future issues.

Anticipated Publication Date: December 1961

59AU210 (Underground Mining) *Blasting Theories and Seismic Waves. Part I: Resume of Recent Blasting Theories* by Arthur W. Ruff.

In the last ten years large gains have been made in the field of blasting. These gains have been both in the theoretical and in the practical application of explosives. One of the most publicized changes in the practical application of commercial explosives is the now-prevalent use of ammonium nitrate and fuel oil. The new water-compatible mixture of ammonium nitrate and TNT should also have a large field of application. Most of the theoretical gains have been concerned with the actual rock breakage obtained with explosives.

59AU109 (Underground Mining) *Blasting Theories and Seismic Waves. Part II: Seismic Wave from Plaster and Drill-Hole Explosive Charges* by Arthur W. Ruff.

The seismic wave produced by an explosive is very important in blasting. A true understanding of the wave is only important when considering possible structural damage to buildings located near the blast, but it is also of primary importance when considering rock fragmentation.

Because of the importance of the seismic wave to fragmentation, a fundamental study of the seismic wave and its effect was made at the Cananea Consolidated Copper Co.'s mine at Cananea, Sonora, Mexico. Strain gages were used to measure the strain in the rock when nearby explosive charges were detonated. The variance in the circuit voltage caused by changes in the resistance of the strain gage was measured with an oscilloscope and recorded with a Polaroid camera.

60F106 (Coal) *Experimental Work in the Degasification of the Pittsburgh Coal Seam by Horizontal and Vertical Drilling* by G. R. Spindler and W. N. Poundstone.

Removal of methane gas from coal seams in advance of mining is not a new idea with mining men and much attention has been given to the possibility for many years. In other parts of the world, a principal concern has been in the recovery and utilization of the gas, and a number of successful projects have been developed in Europe and elsewhere. In this country the principal motivation has been the safety aspect with some possible side benefits with respect to costs and efficiency in mining as secondary objectives.

To date, experimental work in this country has been largely or entirely exploratory to determine bed characteristics with respect to the liberation of combustible gases to investigate or establish the possibility of degasification in advance of mining, and as an aid in projecting mine ventilation systems to provide for safe, effective, and economical handling of combustible gases liberated during mining.

With these objectives in mind, the School of Mines and Engineering Experiment Station at West Virginia University in cooperation with the Christopher Coal Co. of Osage, W. Va., initiated some experimental work in May 1952, and the project has been more or less continuous since then. The work has been centered entirely in mines of the cooperating company in Monongalia County, W. Va., and Greene County, Pa.

60F65 (Coal) *Daily Maintenance and Complete Overhaul of Continuous Miners* by Joseph Mason.

A joint company-manufacturer equipment design program was undertaken. Preventative maintenance—mechanical, electrical, and hydraulic—is covered, including a daily repair and overhaul program.

60B232 (Minerals Beneficiation) *Fatty Acids as Flotation Collectors for Calcite* by M. H. Buckenham and J. M. W. Mackenzie.

This paper describes the results of flotation experiments using stearic, oleic, linoleic, linolenic, and ricinoleic acids and naturally occurring products rich in these acids as collectors for calcite. The results confirm the validity of the rule of Hukki and Vartiainen relating the collecting power and unsaturation of the C18 acids. Reasons for this relationship are discussed and a close relationship between depression and critical micelle concentration is reported.

TN 60B225 (Minerals Beneficiation) *Heavy Media Grinding* by H. J. Oberson and J. H. Brown.

TN 60A214 (Mining) *Lined-Cavity Shaped Charge and Its Use as a Drilling Tool* by Carl F. Austin.

59B78 (Minerals Beneficiation) *Flocculation—Key to More Economical Solid-Liquid Separation* by Robert H. Oliver.

The reasons justifying flocculation in solid-liquid separation systems are explained. Different types of flocculants are described. Preparation and testing are included. An extensive compendium is given.

59F117 (Coal) *Investigation of Materials and Methods of Construction Used for Stoppings in Coal Mine Ventilation Systems* by Charles T. Holland and W. J. Skewes.

Mining companies every year purchase huge amounts of material for the construction of ventilation stoppings. This material by the time it is in place in the stoppings will cost the industry many thousands of dollars. In addition, and more importantly, these stoppings are supposed to confine air travel along certain well defined paths into areas where it is needed to provide safe and healthful atmospheres for workmen. The cost of forcing this air through the mine is large and, in general, increases as the total quantity of air moved increases. Consequently, if the stoppings leak, increased cost results and in addition unsatisfactory ventilation may prevail in the mine. Therefore, it is essential to provide the best possible stoppings at an economic cost.

When attempting to provide the best stoppings possible at an economic cost, three aspects of the problem must be considered. These are: 1) getting the most suitable material for stopping construction, 2) constructing the stoppings so as to get the best performance from the material used, and 3) keeping the cost of stopping construction to a minimum for a suitable stopping. This investigation is concerned with all phases of the problem and has attempted to lay out a study to provide information on all of them.

Abstracts of the following papers appeared in a previous issue (May):

61I223 (Geology) *Magnetic Taconites of the Eastern Mesabi District, Minnesota* by James N. Gundersen and George M. Schwartz.

60B72 (Minerals Beneficiation) *Recovery of Molybdenum by Liquid-Liquid Extraction from Uranium Mill Circuits* by C. L. Lewis and J. E. House.

60B5 (Minerals Beneficiation) *Size Distribution Shift in Grinding* by G. Agar and R. J. Charles.

60L83 (Geophysics) *Model Studies of an Apparatus for Electromagnetic Prospecting* by H. E. Swanson.

TN 60B213 (Minerals Beneficiation) *Flotation of Cummingtonite* by I. Iwasaki, S. R. B. Cooke, and H. S. Choi.

60B103 (Minerals Beneficiation) *Fracture and Comminution of Brittle Solids* by J. J. Gilvary and B. H. Bergstrom.

TN 60B228 (Minerals Beneficiation) *Size Distribution Resulting from the Comminution of Heterogeneous Materials* by D. W. Fuerstenau.

61L6 (Geophysics) *Relationship of Graphite in Soils to Graphitic Zones* by William H. Dennen and Harold Linder.

60B102 (Minerals Beneficiation) *Energy Aspects of Single Particle Crushing* by B. H. Bergstrom, C. L. Sollenberger, and Will Mitchell, Jr.

60H48 (Industrial Minerals) Some Beneficiation *Techniques Applicable to Mineral Fillers* by Donarl R. Irving.

NOTE: Copies of papers will NOT be available until after publication.

BOOKS

(Continued from page 533)

Fiji

Geological Survey Dept.
Box 2020 c/o Government Bldg.
Suva, Fiji

Geology of the Lautoka Area, North-West Viti Levu, Bull. 2, 1959, approx. $1.85 (12s. 6d.) including map, approx. 75¢ (5s.) for map alone.
Regional Geology of Lomawai-Momi Nandronga, Viti Levu (Quarter Degree Sheets 9 and 15), Bull. 3, 1959, approx. $1.85 (12s. 6d.) including map, approx. 75¢ (5s.) for map alone.
Geology of Savusavu Bay West Vanua Levu (Quarter degree sheet 11), Bull. 5, 1959, approx. $1.85 (12s. 6d.) including map, approx. 75¢ (5s.) for map alone.
Geology of Singatoka Area Viti Levu, Bull. 6, 1960, approx. $1.85 (12s. 6d.) including map, approx. 75¢ (5s.) for map alone.
Annual Report for the Year 1959, 1960, approx. 30¢ (2s.).

Ghana

Government Printing Dept.
Publications Branch
Accra, Ghana

Limestones of Ghana, Bull. 23, 1960, approx. $1.60 (11s. 6d.) including maps.

Great Britain

British Information Services
45 Rockefeller Plaza
New York 20, N. Y.

Mines and Quarries Act, 1954, 90¢ plus 5¢ mailing and handling.
Safety in Mines Research, 1958, 37th Annual Report, 90¢ plus 5¢ mailing and handling.
Coal Statistics for Europe, Vol. VIII, No. 2, 2nd Quarter, 1959, $1.35 plus 8¢ mailing and handling.
Coal Industry, 1960, Ch. 17, 9¢ plus 5¢ mailing and handling.
Beetles from the London Clay (Eocene) of Bognor Regis, Sussex, Bull. Geology Vol. 4, No. 2, 1960, $2.16 plus 11¢ mailing and handling.
Interference Methanometers, S.M.R.E. Research Report 172, 1959, 46¢ plus 5¢ mailing and handling.
Dust Explosions in Factories: Speed of Flame in Slowly Moving Clouds of Cork Dust, S.M.R.E. Research Report 166, 1959, 60¢ plus 5¢ mailing and handling.
The Development of Light-Weight Steel Roof Bars for Use at Roadheads, S.M.R.E. Research Report 173, 1959, 93¢ plus 5¢ mailing and handling.
Salt-Crust Treatment of Mine Roads: The Effect of Salt on Haulage Ropes, S.M.R.E. Research Report 174, 1959, 38¢ plus 5¢ mailing and handling.
The Heat-protection of Timber by Silicate-based Coatings, S.M.R.E. Research Report 178, 1959, 46¢ plus 5¢ mailing and handling.
The Formation and Movement of Foam Plugs for Mine Firefighting, S.M.R.E. Research Report 182, 1959, 74¢ plus 5¢ mailing and handling.

Ministry of Power
Safety in Mines Research Establishment
Portobello St.
Sheffield 1, England

S.M.R.E. Bibliography (2nd Edition), 1960, approx. $2.45 (17s. 6d.).

H. M. Stationery Office
York House, Kingsway, W.C. 2
London, England

Annual Report of the Overseas Geological Surveys 1958-59, 1960, approx. 35¢ (2s. 6d.).
The General and Economic Geology of Trinidad, B.W.I., 2nd edition, 1960, approx. $1.75 (12s. 6d.).

Kenya

The Geology and Mineral Resources of Kenya (revised), Bull. 2, 1960, approx. 70¢ (5s.). Order from Ministry of Commerce and Industry, Geological Survey of Kenya, Nairobi, Kenya.

New Zealand

Government Printer
Wellington C. 1, New Zealand

New Zealand Coals, Their Geological Setting and Its Influence on Their Properties, Bull. 134, 1959, approx. $1.95 (12s. 6d.).
Economic Survey 1959, B. 5, 1959, approx. 45¢ (3s.).
Department of Scientific and Industrial Research: Report for the year ended 31 March 1959, H. 34, 1959, approx. 55¢ (4s.).
Geological Map of New Zealand (1:2,000,000), Bull. 68, 1959, paper approx. $3.85 (27s. 6d.), cloth approx. $4.55 (32s. 6d.).

Southern Rhodesia

Geological Survey Office
P. O. Box 8039
Causeway, Salisbury
Southern Rhodesia

The Geology of the Country Around Manguis Mine, Lomagundi and Urungwe Districts, Bull. 46, 1959, approx. $1.60 (11s. 6d.) including map.
The Geology of a Portion of the Inyanga District, Short Report 37, 1959, approx. 55¢ (4s.) including map.
Explanation of the Geological Map of the Country Around Salisbury, Short Report 36, 1959, approx. 15¢ (1s.), map approx. 70¢ (5s.).

Union of South Africa

The Government Printer
Bosman Street
Pretoria, Union of South Africa

The Chromite Deposits in the Rustenburg Area, Bull. 27, 1959, approx. $1.00 (7s.).
Manganiferous Iron Ore, Hematite, Barite, and Sillimanite on Gam (Portion 1), Namaqualand, Bull. 28, 1958, approx. 85¢ (4s. 6d.).
Northern Natal Coal-Field (Area No. 2) The Utrecht Area Records of Bore-Holes 1 to 31 Drilled for the Department of Mines, Bull. 29, 1959, approx. 90¢ (6s. 3d.).
The Geology and Mineral Deposits of the Griquatown Area, Cape Province, 1958, approx. $1.15 (8s.).
Bibliography and Subject Index of South African Geology 1957, 1959, approx. 50¢ (3s. 6d.).

Order from:

Hortors Ltd.
Johannesburg, Union of South Africa

Symposium of Papers on Pumping, Vol. 2, 1960, approx. $2.95 (21s.).

U.S. GEOLOGICAL SURVEY

Order From:

Superintendent of Documents
Government Printing Office
Washington, D. C.

Bull. 1101, Vanadium-uranium Deposits of the Rifle Creek Area, Garfield County, Colo., $1.25.
Bull. 1111-B, Field Description and Sampling of Coal Beds, $1.00.

Order From:

Geological Survey
Washington 25, D. C.

Geologic Map of the U.S. in four quarters NE, SE, NW, and SW, $1.80 per quarter or $6.00 per set.
Topographic Map of San Juan and Vicinity, Puerto Rico, $1.50.

Order From:

U. S. Geological Survey, Federal Center
Denver, Colo.

Preliminary Geologic Map of the Buffalo Mountain Quadrangle, Nev., 50¢.

U.S. DEPT. OF COMMERCE

Publications & Public Information Div., OTS
Washington 25, D. C.

61-11072, New Technical Flow Charts for Concentrating the Manganese Oxide Ores of the Nikopol' Basin, 50¢.
61-11065, Efficient Concentration of Iron Ores, 50¢.

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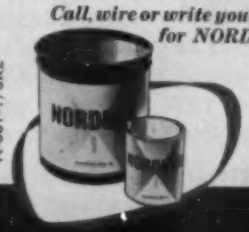

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Milwaukee 1, Wisconsin

Providing more bail pull, maximum dipper fill factor, low per-ton loading cost—Magnetorque Hoist Drive on 17-year-old P&H 1400 refuses to show its age.

After 17 years, first Magnetorque equipped

. . . at MISSOURI PORTLAND CEMENT CO.

Virgil Wendt, Quarry Supt., reports—
"Back in 1944, we bought the first P&H ever sold with Magnetorque; today this 1400 still gives us good, reliable service. If our plant needs extra limestone, we think nothing of working this shovel for 16 hours at a stretch. We still rely on it to do the job for us. Teamed with the P&H 1500 we bought in 1958, it gives us as efficient a digging operation as you'll find anywhere."

Two P&H Electrics Load 1,123,000 Tons Annually

To meet quarry production schedules, Missouri Portland's modern, five-million barrel cement plant demands absolutely dependable equipment. Two types of rock must be dug daily to supply the right "mix." To accomplish this, the two P&H Electric Shovels work at different levels along an 1835 foot long quarry face.

Equipped with a 4-yard dipper, the P&H 1400 has seen years of hard, workhorse service. One year it loaded over 750,000 tons. Now it digs at the base of the quarry's upper face, loading up to 360 tons of limestone an hour. The newer, 5-yard P&H 1500 digs at the base of the lower face, loading up to 400 tons of limestone an hour without hesitation.

Magnetorque Helps Maintain High Production

Exclusive Magnetorque Hoist Drive on these P&H machines is the key to their greater productivity. It gives more digging bail pull—puts more material in the dipper faster, with every pass. Mr. Henry Merz,

20-ton capacity trucks are loaded at the rate of about 15 loads per hour. P&H 1400 with 4-yard dipper shows it's still a workhorse.

Quick, accurate dipper spotting results from responsive electronic controls on 5-yard P&H 1500. Loads 18 to 20, 20-ton trucks per houf.

P&H electric is still going strong

Fort Bellefontaine Quarry in St. Louis County

Quarry Foreman, says—"The electronic controls on our P&H shovels are very responsive and the Magnetorque hoist drive is especially powerful."

Superior P&H Parts And Service Is Worth A Lot

Mr. Virgil Wendt has this comment to make—"I think one big reason the 1400 is still going strong is that P&H really stands behind its equipment with immediate help, should it be necessary. This is worth a lot. Harnischfeger not only builds a good shovel, but helps keep it working right."

Summary Report On 17 Year Old P&H 1400

Here is how Mr. H. Clay Iten, Plant Manager, puts it—"We have no plans to replace our P&H 1400 after all these years. It's always done a good job for us; it's doing a good job for us now, and we expect it will continue to do so."

Compare all performance factors before you buy—for more detailed information on this operation, write for Case History Report No. 141 to the World's Largest Builder of Full-Electric Shovels.

HARNISCHFEGER P&H

Milwaukee 46, Wisconsin

61-599

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International Nickel Selected Marcy Mills for its new Levack Plant

Inco's new 6000 ton per day Levack Mill, in the Sudbury district of Canada, features extensive use of automatic and remote controls designed for maximum efficiency to offset rising costs.
The company states that: "The experience gained from its Copper Cliff and Creighton mills, operating since 1930 and 1951 respectively, proved of great value in designing the Levack Mill." Marcy Mills are used at both Copper Cliff and Creighton.

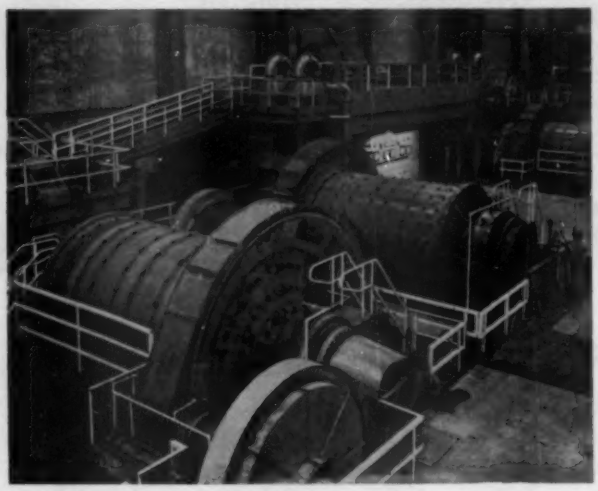
INCO HAS PURCHASED A TOTAL OF 61 MARCY MILLS

International Nickel Company of Canada, Ltd., world's largest producer of nickel, has purchased a total of 61 Marcy Mills including the four at Levack.

TYPICAL EXAMPLE OF MINE AND SMELTER'S WORLDWIDE SERVICE

Canadian Vickers, Ltd., Montreal, Mine and Smelter's sales agent and licensed manufacturer for Marcy Mills in Canada, in cooperation with International Nickel and Mine and Smelter, manufactured and serviced the Marcy Mills for Levack.

PHOTO COURTESY INTERNATIONAL NICKEL



LEVACK MILL. Photo shows one of the two grinding sections. Each section includes one 10' x 15' Marcy Rod Mill and one 10' x 14' Marcy Ball Mill. Central instrument panel controls entire grinding operation.

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ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

Bunker Hill's Concentrator by *Norman J. Sather*—A detailed description of Bunker Hill's concentration process employed at the company's lead-zinc property in the Coeur D'Alene district. **Ref.** (MINING ENGINEERING, **June 1961) p. 573.**

Marginal Analysis—Its Application in Determining Cut-off Grade by *Edward L. Vickers*—The author describes a method of defining that point of ore grade below which rock is uneconomical to mine and process. This system has been applied successfully by a major mineral producer. **Ref.** (MINING ENGINEERING, **June 1961) p. 578.**

Ground Support at the Pitch Mine by *James E. Dunn*—Description of the cribbing method employed at this underground mine. In the past heavy rock pressures have necessitated rapid replacement of all timber and required much maintenance of steel supports. By installing crib sets and lifts and raises this problem appears to have been solved. **Ref.** (MINING ENGINEERING, **June 1961) p. 583.**

Electronic Computations of Open Pit Tonnage and Ore Grade by *R. L. Wilson*—The author details the "pioneering effort" in processing tonnage and ore grade by data processing machines done by Kaiser Steel Corp. Initial work was done on the Silver Lake iron ore deposit. The procedure was later used in determining tonnage and average grade of ore for the Eagle Mountain mine. **Ref.** (MINING ENGINEERING, **June 1961) p. 587.**

Transporting Open-Pit Production by Surface-Underground Haulage by *E. P. Pfleider* and *Cyrille A. Dufresne*—The authors discuss the usage of transfer raises between open-pit mines and underground haulage levels. Special emphasis is given to the consideration of this type of system as it pertains to the Carol project in Labrador. **Ref.** (MINING ENGINEERING, **June 1961) p. 592.**

PERSONNEL

(Continued from page 526)

mining engineer who is willing to work and learn. South. W75a.

Chief Engineer for process design, plant design, new plant construction, and supervision of office for large operation of mining company engaged in phosphate rock mining and processing. Operations cover strip mining, hydraulic transportation, washing and screening plants, flotation plants, dry mill, grinding plant and calcine plant. South. W9721.

Mine Foreman, degree in mining engineering or equivalent, to $12,000, family transportation and housing available, age to 50. Minimum five years recent supervising experience in all phases of open cut mining operations, foreign experience desirable. Demonstrated ability to train local personnel from scratch very desirable. Able to carry out plans to develop and operate a new pit. For a mining and concentrating firm on copper and pyrites. In Europe. Three year contract. SJ-5921.

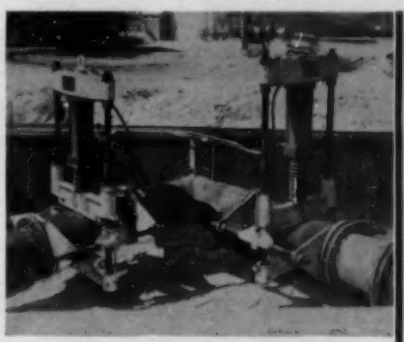
Shift Foreman, salary commensurate, degree in mining engineering, age open, in Southwest. Minimum of three years open pit copper mine supervisory experience plus operating experience. For a copper mining mine and mill. SJ-5914.

Maintenance Superintendent, salary good, in Rocky Mountain state, mechanical background, age 35 up. Qualified by experience in equipment maintenance (shovel, truck, scraper, tractor, diesels, power take off) preventive maintenance of plant and mine equipment. Knowledge of electricity and power distribution applications, able to supervise master mechanics and craftsmen forces. For a mine and mill operation. Housing available. SJ-5912.

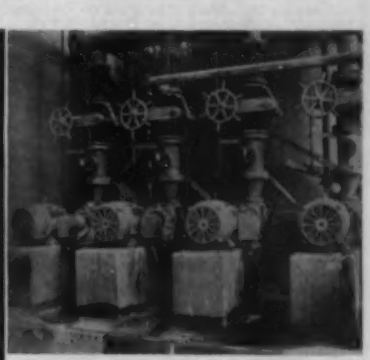
Virginia-Carolina Chemical Corp. Selects Massco-Grigsby Pinch Valves for New Phosphate Plant

200 Valves—sizes from 3" to 10"—types from handwheel to automatic operation.

Based on its previous experience with a large number of Massco-Grigsby Pinch Valves in its plants at Homeland and Clear Springs, the Virginia-Carolina Chemical Corporation purchased approximately 200 M-G valves for its new phosphate plant at Nichols, Florida. These valves were sold and serviced by Mine and Smelter's Sales Agent, R. H. Clark Equipment Co., Inc., Mulberry, Florida.



Two 12" Massco-Grigsby Hydral-Air Pinch Valves on mill tailings line at the Clear Springs Plant of Virginia-Carolina Chemical Corp. Valve system includes solenoids for remote push button control of opening and closing the valves.



Four 6" and four 8" Massco-Grigsby Pinch Valves on the suction and discharge sides of the pumps at Virginia-Carolina Chemical Corporation's new Nichols plant.

Photo courtesy of Westinghouse Electric

Special Advantages of Massco-Grigsby Valves

- Rubber, Neoprene and special compounded rubber sleeves for corrosive and abrasive pulps and liquids.
- Patented "hinged" sleeve. Recesses serve as "hinges" during compression; reduce strain and permit tight closing.
- Unobstructed flow eliminates high friction loss, prevents contamination.

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The Massco-Grigsby Hydral-60 System consists of one or more pinch valves with a single automatically operated hydraulic pump which may be operated by electric motor or air from normal plant supply system . . . permits controlled circuitry for any operating requirement.

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The following list of papers (from the 1961 St. Louis Annual Meeting) will be available until January 1962. Coupons (blue) received with the 1961 Dues Bills and those distributed at the Annual Meeting will be honored until Dec. 31, 1961. Purchased coupon books (yellow) will be honored at any time. As more preprints become available they will be added to this list and bulleted (•).

Preprints may be obtained (upon presentation of properly filled out coupons) **from Preprints, SME Headquarters, 29 W. 39th St., New York 18, N. Y.** Additional coupon books can be obtained from SME for $5 (book of ten) to members or $10 (book of ten) to nonmembers. Each coupon entitles purchaser to one paper. **Please do not use coupons for papers other than those listed by number.**

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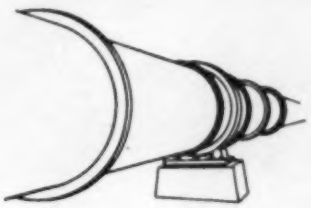

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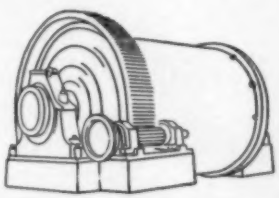

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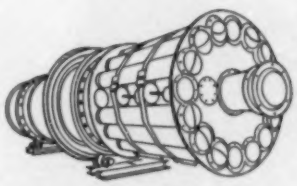
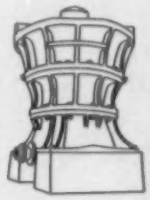
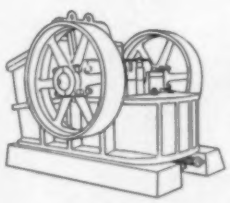


TRAYLOR COOLERS AND DRYERS . . . manufactured in diaphram and multiple tube design, receive the same care in design and construction as Traylor kilns. Dryers are either air cooled or water cooled or both and are available with direct or indirect firing, designed to your capacities or specification.



TRAYLOR GYRATORY CRUSHERS . . . Traylor is world famous as the manufacturer of giant 60" gyratory crushers, secondary reduction crushers and fine reduction crushers. Crushers are designed with Traylor's original non-choking, self-tightening bell heads and curved concaves for large tonnage of small product and uniform size with a low percentage of waste and fines. Power applied as a direct crushing force offers greatly reduced power requirements at every setting.



TRAYLOR JAW CRUSHERS . . . feature the original curved jaw plates for greater capacities at finer settings and longer life of the wearing plates. The swing jaw is made of cast steel of extra heavy design and the pitman shaft is of annealed open hearth forged steel, for lightness with great strength. Maintainence and inspection are simplified by the design which makes all parts readily accessible.

TRAYLOR SLURRY FEEDERS AND TABLE FEEDERS . . . **SLURRY FEEDERS** are self contained, fully closed ferris wheel type feeders . . . accurately supply a constant volume of slurry to kilns and mills. Single welded tank and hopper units are available in sizes from 36" to 84".

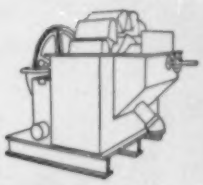


TABLE FEEDERS . . . accurately regulate the flow of material to mills, kilns and dryers. The revolving table receives material at its center from an adjustable feed spout. Feeders available from 2' to 10' in diameter.

See Chemical Engineering Catalog for details and specifications.

TRAYLOR ENGINEERING & MANUFACTURING

DIVISION OF FULLER COMPANY

1554 MILL STREET • ALLENTOWN 1, PA.

4172
TGA-3

Circle the following numbers on the reader service card; 9, rotary kilns, slakers; 10, ball, compartment mills; 11, coolers, dryers; 12, gyratory crushers; 13, jaw crushers; 14, feeders.

An old-timer in California—Photo by Mark Shaw

Mining tells a story

. . . and commercial banks contribute a special chapter

Once upon a time man made do with wood, stone and bone alone.

Then, as legend has it, copper came by accident from the ore-rich rocks of a long-burning campfire.

Inspired by his discovery, man reached out from the age of stone to the age of metals—seeking step by step the utilitarian, the precious, the decorative.

Thus progress has followed the prospector, and the prosperity of nations has come to depend in good part upon mining and metallurgy.

But in modern times people's demand for metals has replaced the prospector with scientific exploration. And where once a grub stake would do, millions of dollars in working capital are now required. For much of this money, modern mining turns to commercial banks.

There are bank loans for getting the ore out of the ground, and loans for processing it. There are loans for transporting raw metals, for converting them into manufactured products. And finally there are loans to bring these products to market where all can see and buy.

That's banking's chapter in the story of mining. And The Chase Manhattan Bank, first in loans to business and industry, is proud to present this tribute to mining, a competitive enterprise providing a variety of products which help Americans exercise their basic right to pick and choose.

THE CHASE MANHATTAN BANK

CHARTERED IN 1799

1 Chase Manhattan Plaza, New York 15, New York

Member Federal Deposit Insurance Corporation

Circle No. 29 on the reader service card.

THIS IS MARION QUALITY

Slam the dipper of a mining excavator against a bank and begin to hoist through tons of unshot ore and strange things begin to happen. Cables whip taut, machine pivotal points are thrown under massive stresses and the entire unit is subjected to component-destroying vibration. It takes exceptional designed-in strength to resist such forces over the profit life of an excavator. Marion gives it to you. In almost 2" of solid, high-strength alloy deck plate for upper machinery support, in the 9-yard Type 181-M, for example. In machinery supporting members that are welded integral with the deck for absolute rigidity. In heat-treatment of the *entire* frame to relieve invisible weld stresses. In careful placement of components to spread operating stresses over a large area for additional stability. The long way around? Perhaps. But the safest—for machine and operator. Marion Power Shovel Company, Marion, Ohio. A Division of Universal Marion Corporation.

MARION

NEWS
FROM MINE AND MILL

HELIUM RESEARCH CENTER ESTABLISHED

Establishment of a Federal Helium Research Center at Amarillo, Texas to permit intensive studies of the characteristics and possible new uses of the lightweight, nonflammable gas was announced by Secretary of the Interior Stewart L. Udall. The center will be operated by the Bureau of Mines and will be supervised by Dr. L. Warren Brandt. Mr. Udall announced that the emphasis on helium studies was ordered because of the increasing importance of this element to space-age technology and its prominent position in the rapidly developing field of electronics.

WELLINGTON MINE REOPENING

Work has recently begun to reopen the Wellington mine near Breckenridge, Colo. Consolidated Parnett is the operator of the mine and general partner in the Wellington Mine Association. The operations presently underway are aimed at cleaning up and rehabilitating the old workings and access ways.

Following the rehabilitation work, a winze will be sunk and a crosscut driven at a new level 230 ft below the present tunnel. Future plans call for the installation of a modern 150-ton selective flotation mill at the portal. The mill will be installed after drifting and raising have been completed on the ore bodies from the 230 ft level. The ore from the Wellington mine has run as high as 19.6 pct lead and 22.9 pct zinc with commercial quantities of gold, silver, and copper. The mining average has been 9 pct lead, 13 pct zinc, 3 oz silver, and 0.05 oz gold.

RUBBER LINING FOR CHUTES AND HOPPERS

Use of bonded rubber lining in chutes and hoppers has solved chronic maintenance problems in coal handling equipment at the Municipal Electric Light plant at Hagerston, Md. Complex bins and diverters that required constant maintenance have been trouble free for five months since the Goodyear rubber lining was placed in service. Due to the satisfactory performance, other trouble areas are being lined.

Chutes and hoppers in the plant's original coal handling system were fabricated of copper bearing steel ¼ in. thick. After handling 120,000 tons of bituminous coal with the equipment, abrasive action of the coal and corrosion from its wet sulfur content resulted in deterioration of the chutes so that extensive repairs became necessary.

The test installation of the rubber lining was made at a main diverter at the head of the conveyor bringing coal into the plant. Two unexpected benefits have resulted from the rubber lining: there is a noticeable reduction in noise as coal moves through the chutes, and rubber covered flanges on the chutes seal tightly to reduce the scattering of coal dust through the plant.

PLASTIC SHEET LINES RESERVOIR—SAVES $24,000 AT COPPER MINE

The largest sheet of polyvinyl plastic material ever fabricated into one piece for industrial use has been installed as the watertight lining in a Bagdad Copper Corp. surge pond near Bagdad, Ariz. This flexible plastic lining is being used to hold a dilute solution of sulfuric acid, copper sulfate, and water used in copper mining and recovery operations at a cost saving of about $24,000 compared to other methods of reservoir construction.

The reservoir is 264 ft long, 114 ft wide, and 7 ft deep with a capacity to hold 1,400,000 gal of acidic copper solution. There is a 34°, 10-ft slope on all four sides. The single sheet of Koroseal vinyl materials is 280 ft long by 130 ft wide, allowing for 2½ ft of tuck-in at each side. The edges are buried in the berm for firm anchorage. According to the contractor, total installation time for the lining was about four hours—representing a considerable saving of time over other reservoir lining methods. The plastic sheet was first laid in a narrow strip down the middle length of the reservoir. Then 12 men, spaced about 20 ft apart, simply picked up the outside edge of the material and walked to the side of the reservoir excavation spreading the lining to its full width.

The huge sheet, covering 36,500 sq ft, was fabricated to exact size in one piece at Long Beach, Calif., then accordion-folded in two directions for shipment in one crate to the Bagdad plant. B. F. Goodrich Industrial Products Co., the manufacturer of the lining material, expects the installation to last indefinitely with proper care. Globe Linings, Inc., realizing that a chain is only as strong as its weakest link, fabricated the liner with electronically welded seams that are stronger than the material itself.

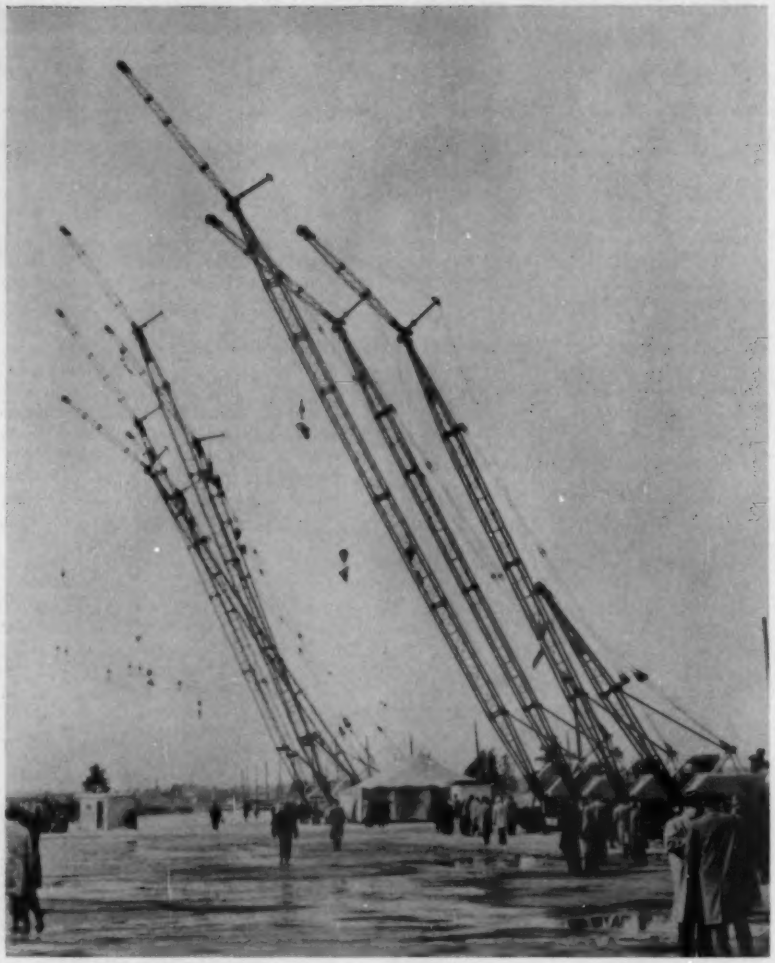
The surge pond is an important step in copper mining and recovery, and it must, of course, be completely watertight to prevent copper loss through seepage. In this recovery operation, the company is reported to process about 20 tons of copper per day in its $2 million leaching plant which operates around the clock.

"OPERATION SURVIVAL"

An immediate program to put some "snap" back into the nation's limping construction and mining equipment business was mapped at a vital "Operation Survival" conference staged at Escanaba, Mich. by Harnischfeger Corp. In a public statement, Jack F. Catalane, head of the company's construction and mining equipment division, said, ". . . a burst of new emphasis must be directed toward training, advertising and marketing, and individual effort all down the line."

Mr. Catalane quoted construction outlook statistics which had been aired at the meeting. "It is a matter of record that the potential for our industry has never been greater," he noted, "and we very frankly feel that, as we now make ourselves better qualified to take advantage of that potential, the 'recession' will pretty well take care of itself." The company is doubling the sales training budget for construction and mining equipment. One innovation will be a "traveling sales training school" which will soon begin a year-long tour of the U.S., spending several days of each week with dealers' salesmen.

Additional support for the push toward a better sales climate came with the first dealer showing of the company's 1961 line of "Fabulous 40" power cranes and shovels. It was also revealed that the company had just entered into an agreement to import for the first time new types of European building cranes. An agreement has been signed with Liebherr (Ireland) Ltd. to market the latter firm's tower cranes and climbing cranes throughout the U.S. under Harnischfeger's P&H trademark.



The intensive "Operation Survival" program included part of an afternoon during which the 300 delegates viewed the 1961 P&H line of "Fabulous 40" cranes and shovels.

AGREEMENT SIGNED BETWEEN TRI-STATE AND AMERICAN ZINC

An agreement to mine and mill at least 20 million tons of zinc-bearing ores in a $6 million project near New Market, Tenn., was made between Tri-State Zinc, Inc. and American Zinc Co. of Tenn. Under the joint venture agreement, Tri-State will mine and mill the ore deposits owned by American Zinc.

The agreement confirms a previous understanding which was reached in principle early in 1960 between the two companies whereby Tri-State agreed to extend the drilling program carried out by American Zinc between 1954 and 1957, and, upon the successful completion of this program, to develop the mine and erect a treatment plant. It is expected that the treatment plant will have a capacity of 2800 tons of ore per day by summer of 1962; this is expected to ultimately reach 3600 tpd. While the mine is being developed, excess mill capacity will be utilized for milling ore from the nearby mines of American Zinc.

COMPANY BUILDS NEW HEADQUARTERS

United States Borax & Chemical Corp. has negotiated a long-term lease agreement with the Carter Co. providing for the construction of a new U.S. Borax headquarters building in Los Angeles. The 275,000-sq ft office and parking structure, to be located at Wilshire Blvd. and Westmoreland Ave., will be ready for occupancy early in 1963. U.S. Borax will lease the nine-story building for an initial term of 30 years with options to extend the lease for two additional 10-year periods.

URANIUM CONTRACT

The Atomic Energy Commission has signed a new contract with Union Carbide Corp. through its Union Carbide Nuclear Company for the purchase of uranium concentrates to be produced by the corporation's uranium processing mills at Rifle and Uravan, Colo. The agreement replaces separate contracts for the two mills that would have expired on March 31, 1962.

The new contract, which became effective April 1, 1961, and extends through December 31, 1966, provides that the government will purchase uranium concentrates valued at approximately $100 million. Up to 12,154,730 lbs of U_3O_8 may be delivered during the term of the contract.

AIR SEPARATOR CLASSIFIES 350 BBLS OF CEMENT FINES PER HOUR

An 18-ft Sturtevant air separator at the Huron Portland Cement plant in Alpena, Mich. is turning out over 350 bbls per hr of 88 pct 325 mesh cement fines testing 1650 on the Wagner scale. The unit, powered by a 250-hp motor, is achieving this selection in normal production of 350 to 370 bbls per hr. Figures collated during early operations when mill #19 was started last fall showed operating rates generally in the 370 bbl range—one 24-hr run gave a 416.2 average, another gave a 410.2 average. Raw clinker fed into the unit is crushed in a two-compartment, 2750 hp, 12 x 36-in. Kennedy Van Saun Compeb mill.

BRAZILIAN BERYL TO BE EXPLOITED

Standard Beryllium Corp. has obtained a 100 pct interest in Boa Vista in Brazil. Boa Vista contains proven and probable beryl reserves of approximately 350,000 tons on a 1700 acre site approximately 200 miles north of Rio de Janeiro. The first phase of activities should be completed near the end of 1961.

The company is negotiating with Bruce W. Odlum and Beryllium Resources, Inc. to use their flotation process in a new concentration mill to be constructed on Standard's Boa Vista property. The process, which was originally developed using beryl of the type found at Boa Vista, is expected to produce 2500 tons of beryl concentrate per year. At today's market price of $35 per unit (equal to $400 per ton), this equates to $1 million additional annual sales. Construction of the mill is expected to begin late this year, with completion scheduled for early 1962.

LIMESTONE UNDER MISSOURI RIVER

Studies by the Geological Survey of the Department of the Interior have disclosed the presence of a buried limestone bench or bedrock platform 90 ft beneath part of the Missouri River flood plain in an area south of Council Bluffs, Iowa.

Completion of a series of flood control dams along the Missouri River upstream from Omaha, Neb. and Council Bluffs affects discharges from about 80 pct of the drainage area above those cities. The remaining 20 pct, or 59,300 sq miles of uncontrolled drainage area, could produce a major flood. However, in April 1952 during the greatest flood ever observed there, an extensive levee system successfully protected those portions of Council Bluffs and Omaha located on the flood plain. Since 1952 the drainage area contributing uncontrolled flow has been greatly reduced with corresponding reduction in the likelihood of inundation of the flood plain.

TEXAS URANIUM MILL OPENED

Susquehanna-Western, Inc. recently put Texas' first uranium ore processing mill into operation. The 200 tpd facility, located 60 miles south of San Antonio, is specially designed to handle locally-produced ores having a high bentonite and moisture content. The process consists of calcining, acid leaching, CCD washing, and solvent extraction for recovery of uranium values. Ore to be processed is mainly derived from company mines in southern Texas.

The company received the Atomic Energy Commission contract on July 25, 1960. The mill, involving an investment of approximately $2 million, was designed and constructed by the company. Capacity of the plant was achieved during the first day, and uranium concentrate produced on the third day of production.

NICKEL-COBALT CALCINES PURCHASED FROM G.S.A. STOCKPILE

The U.S. Government stockpile of some 3500 tons of nickel-cobalt calcines located near Fredericktown, Mo., has been purchased by Sherritt Gordon Mines Ltd., Toronto, Canada for approximately $700,000.

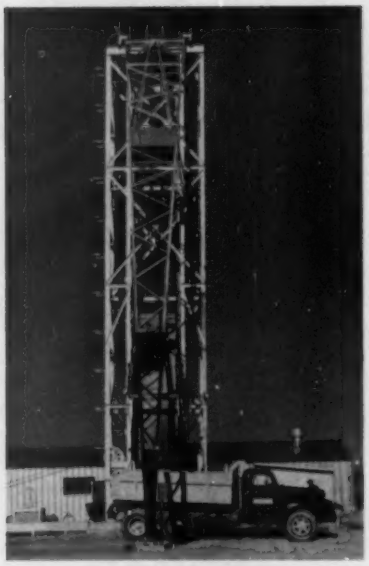
The calcines are about 19 pct nickel and 13 pct cobalt. During World War II the U.S. Government operated a refinery near Flat River, Mo., for the refining of lead and copper concentrates and produced these calcines as a by-product. The calcines were declared excess to national stockpile needs by General Service Administration earlier this year. Sherritt will move the calcines to its nickel and cobalt refinery at Fort Saskatchewan, Alberta, Canada where its principal refinery feed is nickel concentrates from its own Lynn Lake, Manitoba mines.

CONVEYOR BELTS MOVE OVERBURDEN 400 FT AT 5100 TPH

A Bucyrus-Erie 1054-WX wheel excavator is partially responsible for increasing annual bituminous coal output by a million tons at Peabody Coal Co.'s River King mine in Freeburg, Ill. This is the latest, and one of the largest (176 ft. high) machines of its type to be put in use in this country. Working in conjunction with a 70-yd shovel, it digs material on one side of a 100-ft open pit, then carries the dirt on 54-in. conveyor belts operating at over 1000 fpm, to the pile some 400 ft away.

According to the manufacturer, the most important statistics about the earthmoving capacity of the wheel excavator are those concerned with the conveyor system. It is the speed of the belts, times

their capacity, which determines the maximum performance possible. Two conveyors are incorporated in the machine. One, the digging ladder, is on the business end of the machine; the other is the stacking conveyor, mounted on the stacking ladder. The 10-ply digging belt totals 203 ft; the 7-ply-stacker belt is 732 ft long. Both were made by Raybestos-Manhattan. Belt speeds are so high they were considered virtually impossible for this type of service a few years ago. Normal running speed for the digging ladder belt is 900 to 1000 fpm, and for the stacker conveyor belt, 1000 to 1150 fpm. At these speeds, the unusual flexibility built into the conveyor belts permits them to handle the 9-yd working capacity of the excavating wheel, which is capable of turning seven rpm in chewing up 5100 tph of overburden.



PROJECT GNOME

PEACEFUL USE OF NUCLEAR EXPLOSIVES ANTICIPATED

Sometime in 1961, if Presidential authorization is obtained, a nuclear device about half the size of the Hiroshima bomb will be detonated in a small chamber cut in the salt beds 1200 ft below the surface of a desolate area of New Mexico. Known as Project Gnome, the planned explosion of a 10-kiloton nuclear device is part of the Atomic Energy Commission's Plowshare Program organized to investigate the feasibility of using nuclear explosives for peaceful purposes.

More specifically, the Atomic Energy Commission has listed four main objectives for this project: 1) To explore the feasibility of converting the energy released by nuclear explosion into heat for the production of electric power. 2) To investigate the practicability of recovering useful radioisotopes for scientific and industrial applications. 3) To increase information available on characteristics of underground nuclear detonations to a new medium. (Salt has marked differences from the volcanic rock at the Nevada test site where previous underground tests have been made.) 4) To measure neutron cross-sections, thus obtaining information which will contribute to the further development of nuclear reactors.

The site of the shaft is about 25 miles southeast of Carlsbad, N. M., a region hitherto the almost exclusive province of mesquite, cactus, and rattlesnakes. Sinking the 12-ft diam, 1200-ft vertical shaft is The Cementation Company of America, Inc. of Wilmington, Del. The company has sunk deep shafts in many parts of the world including those for coal mines in Great Britain, gold mines in South Africa, and salt mines in Canada and elsewhere. When the vertical shaft is completed, the company will drive a 1146-ft horizontal tunnel, 8x12 ft, to "zero station." The explosive, which is equivalent to 10,000 tons of TNT, will be placed at this point.

Special grouting techniques will be required when the shaft is sunk to the Culebra Member, between 498 and 532 ft. Part of the Rustler Formation, the Culebra Member is a notorious water-bearing strata in a region where solution openings are commonplace. Test borings indicate a minimum flow of 100 to 150 gpm at this level. When the operators have sunk the shaft to within 50 ft of the water level, bore holes will be put down. After 10 ft of casing has been cemented in position within the bore holes, special high pressure valves will be installed on the casing pipe. Operators will then drill into, through, and out of the water-bearing ground as pumping and grouting proceed. The vertical shaft will be concrete-lined to the top of the salt beds at 715 ft.

Since the start of the project in September 1960, three mechanics have been assigned to each of the three daily shifts. Each day they inspect hoist house equipment and generators. Also paid particular attention each day are the wire rope, and the sheaves and crosshead on the head frame.

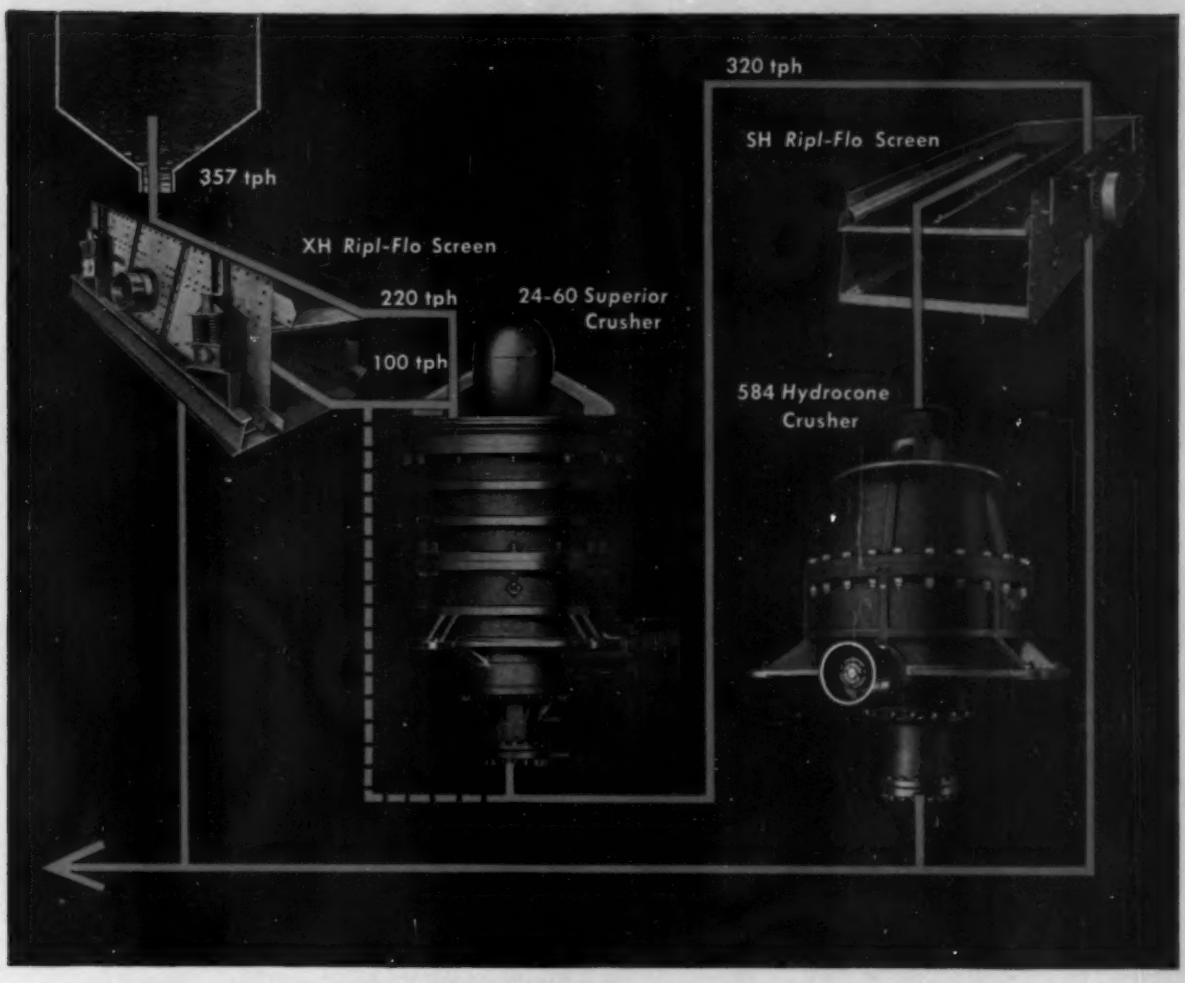
Welders on hoist house are shown installing safety shafting to prevent heavy rope from catching on sharp edges or angles.

Power is furnished by a 600 kw generator (the main source) and two 150 kw generators, both of which were used in AEC experiments on Eniwetok Atol. As a precaution against failure, a second unit about the size of the larger generator is to be brought to the site in January, 1962. In the meantime, the detergency level and oxidation stability of Gulf Dieselmotive 77 keeps components free from varnish and heavy deposits, and reduces wear on moving parts.

A 700-hp hoist is the principal piece of equipment in the hoist house. Its function was outlined by Mr. Black, Project Manager: "For fast sinking, the hoist must have a high winding speed and a large load capacity. It operates in a range of seven speeds from the slow speed used to lower the miners, up to the 1500 fpm winding-in speed."

Miners and foreman prepare to exchange the bright sunshine of New Mexico for the darkness at the bottom of the concrete-lined shaft they are sinking into the salt beds.

ALLIS-CHALMERS



King-size crushing job—from 16" feed to ¾" product—with

two crushers instead of three

Two important efficiency factors were the key to a new installation in Southwest "copper country."

First of all, only Allis-Chalmers could furnish the right-sized crushers to do the job. A 24-60 *Superior* gyratory is the primary crusher for reducing raw 16" ore down to 2½". Final crushing, down to ¾", calls for a 584 fine chamber *Hydrocone* crusher. It's normally a job for three crushers — but these two do the job dependably . . . and both are equipped with time-saving *Hydroset* controls.

Secondly, A-C engineering service specializes in designing plant flows that bring out the best in equipment . . . designed for maximum efficiency, step by step, from bin to storage pile.

Ask your A-C representative about complete engineering service and the size range of A-C crushers. Or write **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1335

SUPERIOR gyratory crushers are built for rugged primary and secondary crushing loads. Capacities from 170 to 3500 tph. Twelve sizes.
HYDROCONE crushers, built to economize on secondary and tertiary stages, have capacities from 7 to 1050 tph. Twenty-one sizes.

Superior, Hydrocone, Hydroset and Ripl-Flo are Allis-Chalmers trademarks.

Circle the following numbers on the reader service card: 19, Superior; 20, Hydrocone; 21, Hydroset; 22, Ripl-Flo.

new

JR-300 JACKDRILL

Challenges Comparison

50% Higher Drilling Speed and Easier Operation Assure Maximum Production at Lowest Capital Investment

Never before in the history of rock drilling has there been a feed-leg drill that could do so much, so easily, as Ingersoll-Rand's new JR-300 Universal Jackdrill. On performance alone, it is 40 to 60% faster than preceding models.

The JR-300 is a lightweight, completely integrated rock drill and flexible air-feed leg unit designed for faster, easier drilling in any position. Three feed legs are available with this new machine: conventional single-acting, telescopic and a new double-acting automatically retractable feed leg. All controls are conveniently grouped on the backhead and the feed handle has a two-position button for feed release or leg retraction which reduces steel changing time and speeds setups.

The same fine performance and design features are available in the new R-300 Stoper and J-300 Jackhamer, simplifying parts inventory where all three types of machines are used. For a new high in drilling speed and economy, ask your Ingersoll-Rand representative for a demonstration of the new JR-300 Universal Jackdrill—or send for a copy of Bulletin 4219 today.

Ingersoll-Rand
11 Broadway, New York 4, N. Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK

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FIRST CLASS
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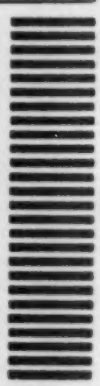

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THE WHEAT SYSTEM

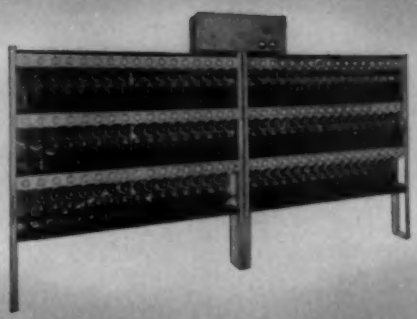
OF CONTINUOUSLY-IMPROVED COMPONENTS

CAP LAMPS

30% more light . . . finger-tip focussing . . . a perfect spot, every time

CHARGING EQUIPMENT

Fully automatic . . . electronically controlled . . . transistorized . . . true self-service



SERVICE

Competent . . . experienced . . . conveniently located in the major coal mining areas

—always

your best choice in better light for the miner

Yes, *whenever* you join The Trend to WHEAT, you enjoy the highest present development in better light for your men underground. And year after year, you benefit by steady, consistent, persistent improvement in every component of the Wheat System. You have *always* a cap lamp system modern as today—promptly equipped with the developments of tomorrow! *Talk over these facts with your National Mine man, in detail—now.*

National Mine Service Company

Koppers Building Pittsburgh 19, Pa.

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Circle No. 26 on the reader service card.

PRODUCTS

FOR MINE AND MILL

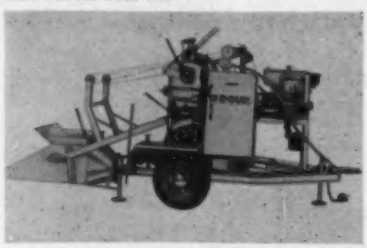
Tractor-Scrapers

Two new wheel tractor-scrapers, featuring a torque divider power shift transmission, have been announced by *Caterpillar Tractor Co.*

The machines are the four-wheel 630 Series A and the two-wheel 631 Series A (shown above). Both tractors are powered by a four-valve-in-head diesel engine that has a maximum rating of 420 hp and a flywheel rating of 335 hp. The 630A has a top speed of 41 mph and the 631A, 31 mph. Other machine features include specially developed 28 ply 29.5 x 35 tires, air-actuated cable controls, advanced design steering system, and a high degree of service accessibility. Scrapers are of low-bowl design and have a struck capacity of 21 cu yd and a heaped capacity of 28 cu yd. **Circle No. 76.**

Concrete Gunning

A portable gun for both wet and dry gunning and pressure grouting has been manufactured by *Air Placement Equipment Co.* The WD gun features a Roto-Rol mixer in a top pressure vessel to assure continuous operation. An augermatic feed provides positive flow control with a continuous feed from a single outlet for smooth, uninterrupted flow of material. A skip loader with pedal control screens sand and cement into separate compartments. The gun also features a built-in water meter variable feed control and a 15-in. fill door with a self-cleaning, self-sealing slide valve. Production capacities of the machine are four cu yd per hr with 25 cfm of compressed air. **Circle No. 77.**

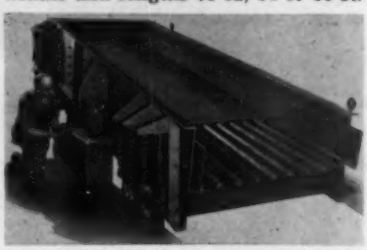


Free-Cutting Red Bit

A flat, full-width carbide tip is featured on the Style CMF red bit by *Vascoloy-Ramet Corp.* Side clearance eliminates drag and gives fast, free-cutting action with minimum fines. The carbide tip is held securely in the bit by a rigid lip design; and a full collar sets solidly on all sides for a steady fit in the quick change block. It reportedly promotes uniform lug wear, increases retaining pin life, prevents carbide breakage, and keeps fines from packing in the lug. **Circle No. 78.**

Vibrating Feeders

A standard line of heavy duty vibrating feeders for controlled conveying and feeding aggregates, ores, and coal has been developed by *Allis-Chalmers.* The vibrating feeder is available at 5° and 10° slopes with solid pan deck or partial pan in combination with a grizzly section at the discharge end. The feeders are available in 3, 4, 5, and 6-ft widths and lengths of 12, 14 or 16 ft.



The machine's cast manganese grizzly bars are individually adjustable and replaceable. Bracket type floor mountings have steel coil springs and friction checks for maximum vibration isolation. The feeder, with replaceable pans and sideplate liners, can be supplied with either a standard, high torque or a variable speed, or rotor motor with pivoted base when variable feed rates are needed. **Circle No. 79.**

Steel Alloys

Stronger alloys have been incorporated by *Sprang and Co.* into its line of cable system tools for the water, gas, mining, and petroleum industries. First products to be marketed (under the name of Spangaloy) will be drilling jars and stem boxes. Drilling jars made of this material, reportedly offer two to three times the normal service life of earlier-made jars, and service life of stem boxes has been increased up to five times. **Circle No. 80.**

Truck-Mounted Excavator

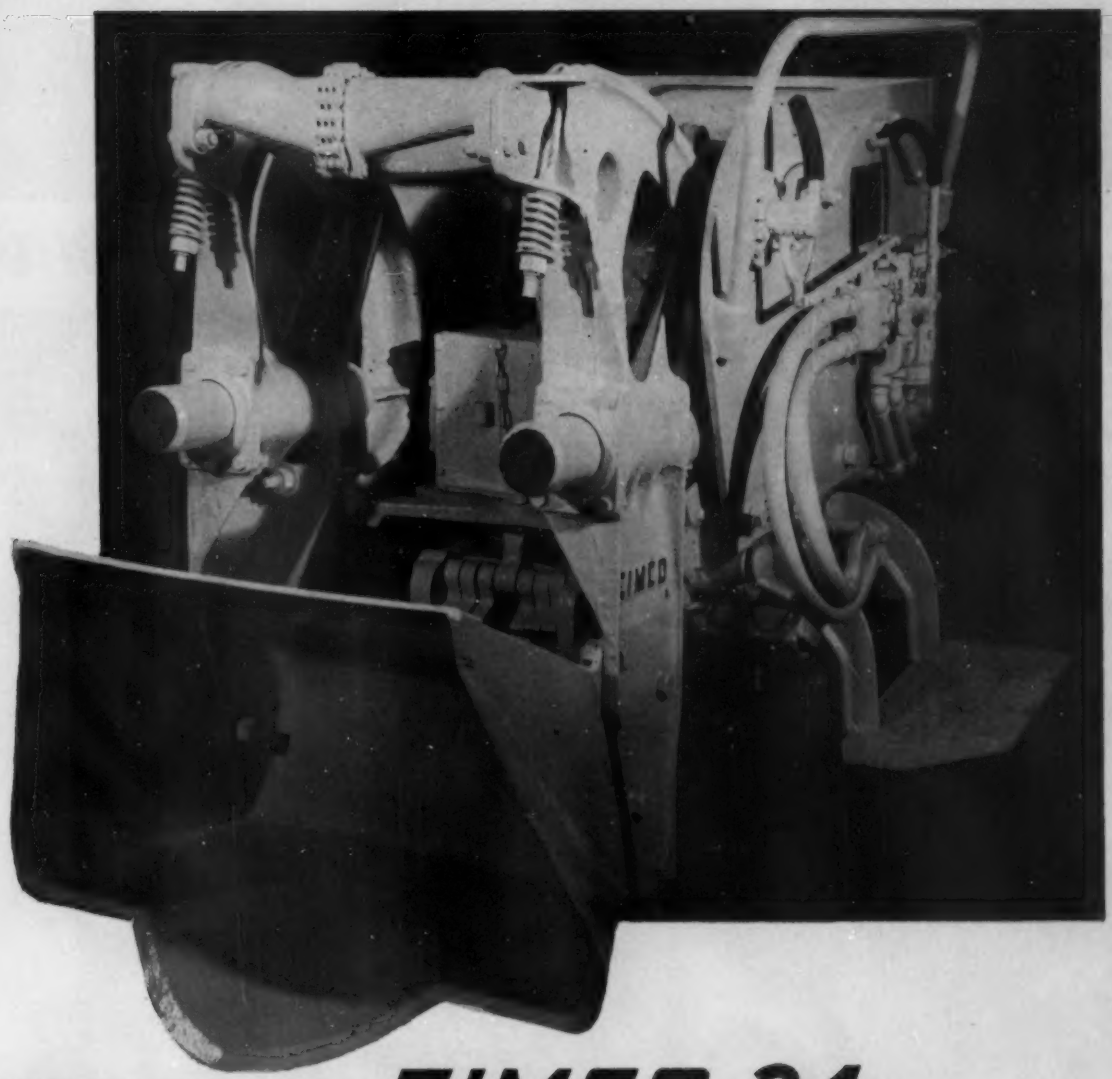
The P & H model 155B-TC by *Harnischfeger Corp.* is a 15-ton capacity, truck-mounted unit for use as a dragline, clamshell, shovel, crane or backhoe. Special features of the machine include: a system which completely encases and continually lubricates major gears and shafts; a gear type boom hoist which utilizes engine power for lowering the boom, thus giving a greater margin of safety and precision; and a roller

circle supporting and smoothing rotation of the engine-operator cab. **Circle No. 81.**

Dust Collector

Series No. 20 centrifugal dust collectors, developed by *Torit Manufacturing Co.* provide up to 2500 cfm of air with a 5-hp motor. Capacity of the Series No. 20-3 (3 hp) ranges from 1250 to 2000 cfm, and the No. 20-5 (5 hp) to 2500 cfm. Variations of these separators include models with after filters for indoor exhausting and enlarged dust storage and hopper capacities. A total of 12 models is available in the series. Series No. 20 was designed to handle materials such as dust, chips, shavings, and blocks from wood, metal, and plastics, as well as materials having the consistency of flour, etc. The blower features a self-cleaning, radial design wheel, developed to handle light materials without clogging. The fan is also located on the "clean" air side of the unit to prevent damage from large or heavy pieces of material. **Circle No. 82.**

(Continued on page 558)



COMPARE the EIMCO® 24 RockerShovel® Loader

Compare loading capacities. Compare construction quality. Compare operating costs. Compare ability to fully and easily load longer, bigger cars. Get all the facts on the faster loading, more versatile new Eimco 24 RockerShovel loader, proud successor to the famous Eimco 21, before you buy any rail-mounted loader and you'll agree that here is indeed a new standard of performance and quality. Write for Bulletin L-1140-A, containing facts and specifications and ask for the location of your nearest Eimco Branch or Dealer.

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"Advanced Engineering and Quality Craftsmanship Since 1884"

Circle No. 25 on the reader service card.

385 HP! FROM CATERPILLAR THE NEW D9G

MASSIVE HEAVY-DUTY UNDERCARRIAGE. Immense strength and rigidity of undercarriage is one good solid reason why the D9G is more than equal to the roughest ripping job. Box section frame is wider and deeper than previous models. Hydraulic track adjusters are standard. Lifetime lubricated rollers with special alloy deep hardened rims assure long life . . . and they require no servicing until time to rebuild.

Circle No. 26 on the reader service card.

HIGH-PRODUCTION DOZER, PUSHER, RIPPER

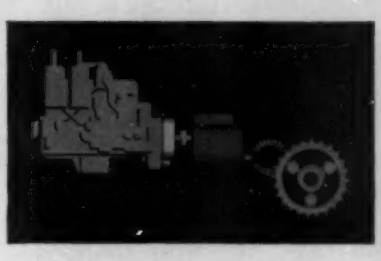
For high-volume dozing, pushloading or ripping, the new D9G has what it takes . . . at minimum cost per yard!

The engine in the new D9G delivers 385 flywheel horsepower. That's *100 more horsepower* than the first D9 introduced five years ago!

Weight is 64,800 pounds—14% more than the first D9!

Torque divider power shift transmission . . . massive heavy-duty undercarriage . . . and power train with built-in ruggedness for long life.

What else is new? Matching the D9G is a full line of attachments—all designed to help this new tractor really put out on the toughest big jobs.



CAT D353 ENGINE AND MATCHED POWER TRAIN This engine, rated 385 HP (flywheel) at 1330 RPM, has been proven—and proven again—over thousands of hours on the roughest jobs. Its 6.25" x 8" six-cylinder design now incorporates *controlled turbocharging* and aftercooling (found only in the D9G among crawler tractors), assures more efficient use of fuel, increases maximum torque and provides fast engine response over a wide range of operation. Shroud-mounted fan reduces air recirculation; torque limiting clutch saves on fan horsepower. Plus: exclusive Caterpillar fuel injection system, twin dry-type air cleaners, oil-jet-cooled pistons, "Hi-Electro" hardened cylinder liners and crankshaft journals.

The new power train includes three major advances: *new oil-cooled steering clutches and brakes, new planetary final drives*, and a time and cost saving *common lube system*. The new spring-engaged, hydraulically-released steering clutches need no adjustments . . . have a proven longer service life. New, planetary final drives increase gear reduction ratios from 8.8:1 to 18:1, reducing torque load on all power train components. A common system cools and lubricates torque divider, transmission, bevel gear, steering clutches and brakes. This means one service point . . . one type of oil. The entire power train of the big new D9G has unitized construction for fast, individual removal of components.

PROVEN TORQUE DIVIDER POWER SHIFT This exclusive Caterpillar design feature—standard equipment on the D9G—combines the efficiency and snap of direct drive with the load-matching and anti-stall characteristics of torque converter. A single lever gives the operator finger-tip control of his machine. It adds up to fast cycle times and greater efficiency. You get more out of the machine *all day*.

A FULL LINE OF HIGH-PRODUCTION ATTACHMENTS New cable controls with larger clutch, brake and drum capacities—hydraulically boosted . . . new hydraulic controls in nine arrangements . . . special cushioned pushing equipment . . . angle, straight and U dozers, cable or hydraulic . . . rippers . . . scrapers . . . and others.

To prove the D9G's productive capabilities on your job, talk to your Caterpillar Dealer.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

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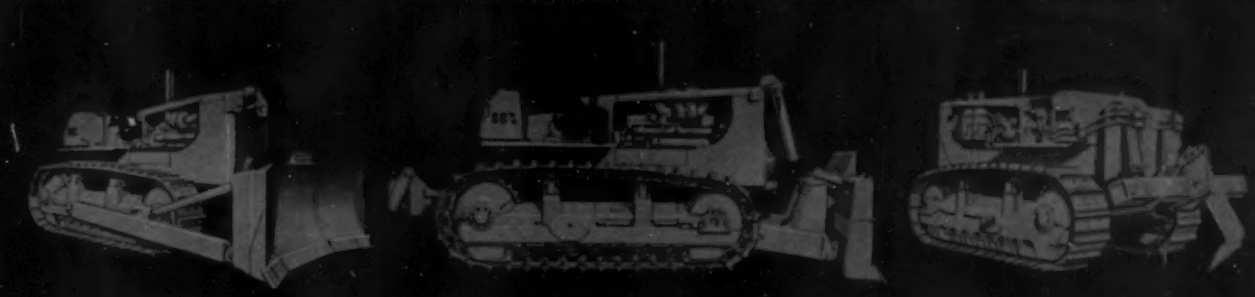
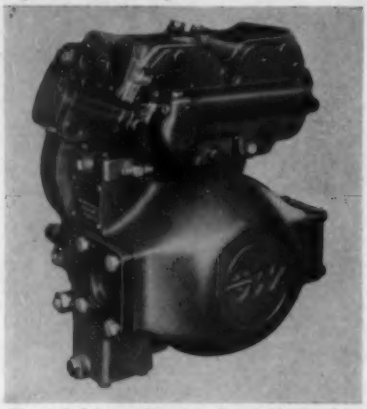
NEW D9G—BIG, POWERFUL, PRODUCTIVE



PRODUCTS
FOR MINE AND MILL

(Continued from page 554)

Hydraulic Pumps



A variable volume piston type hydraulic pump has been announced by *Gar Wood Industries, Inc.* Called the Variacs, the pump is now standard equipment for attachment operation on the Euclid C-6 crawler tractors. A significant advantage of the Variacs pump in operating hydraulic attachments on heavy duty equipment is that the variable volume permits the pump to function only on demand. Unlike conventional hydraulic pumps, no oil is pumped in hold position, and the machine pumps only the amount of oil required to do the job. The variable volume affords more work with less horsepower. **Circle No. 83.**

Ionization Chamber

An integrating ionization chamber for measuring high intensity radiation from radioisotopes, x-rays, and pulsed beam sources has been developed by *Nuclear-Chicago Corp.*

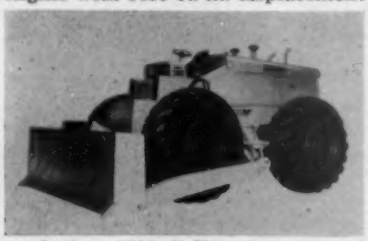
Model P18-M instantaneously measures total radiation received independently of the flux rate. It continues to indicate accumulated radiation for extended periods of time. This chamber has three linear ranges of 0 to 0.25, 0 to 2.5, and 0 to 25 roentgens, and may be used in X-ray beams as great as 200 roentgens per minute. **Circle No. 84.**

Chemical Analyzer

A differential AutoAnalyzer for continuous chemical analysis, with automatic blank or interference compensation, that can detect trace materials down to parts per billion with an accuracy of 1 pct has been introduced by *Technicon Controls, Inc.* Providing analysis with exact reproducibility, the analyzer automates all steps of a chemical analysis now performed manually, and integrates them into a continuous flow system. The instrument system automatically measures, mixes, purifies, compares, and records. It also runs 20, 40, or 60 complete tests without the need for supervision. **Circle No. 85.**

Tractor Dozer Engines

The *Construction Machinery Division* of *Clark Equipment Co.* has introduced two horsepower-increasing engine options for their Model 380 (Series II) tractor dozer. First of the optional engines is the General Motors Model 12V-71, a 430-hp diesel. It is a 12 cylinder, two-cycle diesel with 851.2 cu in. displacement which produces a maximum of 1210 ft-lbs of torque at 1200 rpm. The other power plant is the Cummins Model NVH, a 12 cylinder diesel rated at 450 hp. It is a four-cycle engine with 1486 cu in. displacement



producing 1232 ft-lbs of torque at 1500 rpm. Driven through the Clark power train, Model 380 has a top speed of 28.6 mph in forward or reverse. The drive line consists of a construction machinery type 3:1 multiplication factor torque converter, four-speed power shift, and four-wheel drive. **Circle No. 86.**

Drilling Accessory

An "A" screw, designed to fit Chicago Pneumatic diamond drill Nos. 55 and 65 has been manufactured by *Granite Drill Mfg. Co.* Use of this screw is convenient where an "AX" hole (1⅞ in. diam.) is required. An "A" drill rod can be used right through the machine instead of using an "E" rod which would necessitate adapting the "E" rod to an "AX" core barrel. The "A" rod reportedly cuts vibration to a minimum and helps to reduce wear while considerably increasing the footage with the diamond bit. The "A" screw, made of a fine grade of high-carbon steel, is priced at $98.50; complete "A" screw assembly, including screw, jaws, chuck, and wrench, costs $194.50. **Circle No. 87.**

Flashlight Clipboard

The Ray-Rite flashlight clipboard with a two-battery head provides illumination of the entire writing surface for those who have the problem of writing in totally dark or poorly lighted areas. These flashlight clipboards, designed by the *Mutual Engineering & Mfg. Co.*, are made

for three standard office size forms: invoice size (7 x 12 in.), letter size (9 x 13 and 9 x 14 in.), and legal size (9 x 16 and 9 x 17 in.). The invoice size, with clipboard material of either tempered Masonite in Hammertone Aluminum, has a two-battery capacity; letter and legal size are furnished in either two or three-battery capacity. Where large size clipboards are necessary, heads are available in both two and three-battery capacities. Prices of the clipboards range from $5.30 to $9.50. **Circle No. 88.**

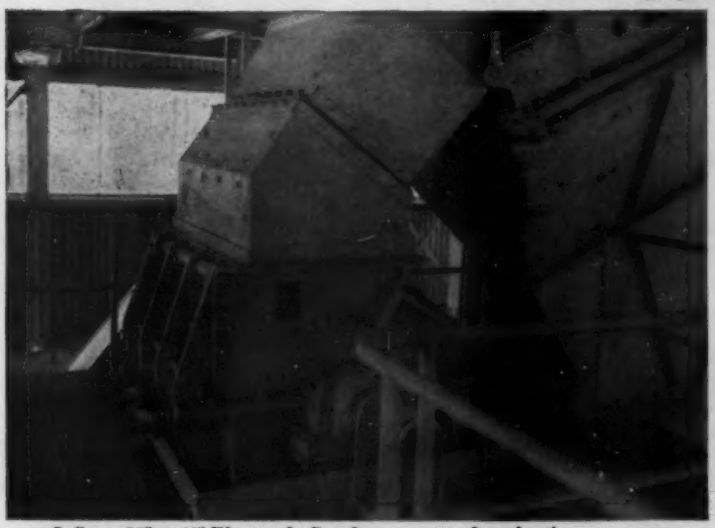
Electric Cord Reels

Cordomatic Reels is making a blanket offer to industry for a 30-day free trial of its reels. The company is also offering an on-the-spot free plant check-list survey which illus-

trates the various uses of the reels. The reels are equipped with a cord which extends and locks to any desired length and retracts automatically. These portable, easily-installed reels have phenolic handles and heavy-duty neoprene cord. The units carry an unconditional guarantee. **Circle No. 89.**

If you're mining or milling potash, JEFFREY can speed your operations

Jeffrey Crawler-Loader working at salt mine installation



Jeffrey 36" x 48" Flextooth Crusher on potash reduction

Flow of materials is handled by Jeffrey Vibrating Feeders

For over 80 years, Jeffrey has been serving industry with equipment for mining, materials handling and processing. This long service has earned for Jeffrey a world-wide reputation for sound engineering design, quality workmanship and exceptional service.

In your production of potash or other materials, Jeffrey offers equipment to help you do the job faster, more economically. Typical Jeffrey machinery serving industry is shown on this page.

Jeffrey wire rope type belt conveyors (not shown) have interchangeable idler rolls, and spacing of idlers can be easily changed to suit material being conveyed. For recommendations on this and other Jeffrey products, write The Jeffrey Manufacturing Company, 865 North Fourth Street, Columbus 16, Ohio.

JEFFREY

If it's conveyed, processed or mined, it's a job for Jeffrey.

Circle the following numbers on the reader service card: 15, Crawler-Loader; 16, Flextooth Crusher; 17, Vibrating Feeders; 18, Conveyors.

DATA

FOR MINE AND MILL

(101) CAREERS IN THE MINERAL INDUSTRY: "Opportunities Unlimited", a booklet designed to introduce high school and college students to the various careers available in the extractive industry, may now be obtained from the Society of Mining Engineers of AIME. Describing the various aspects of the industry, from exploration to mineral beneficiation, the booklet also discusses such subjects as secondary and college training, selecting a college, the cost of a college education, and the opportunities awaiting a new graduate in mineral engineering.

(102) RAIL EQUIPMENT: Catalog No. 10, illustrated with the latest product developments for the mining and industrial fields, is now available from the *Nolan Co.* New products include all-steel push cars, tool and supply car, track dolly carry-cart, rail dolly, and bumping posts. In addition, the company's standard line of rerailers, derailers, and car door openers, are featured in the bulletin.

(103) INDUSTRIAL MOTORS: Bulletin B-2515, issued by *Reliance Electric & Engineering Co.*, illustrates and describes the complete line, (1 to 2000 hp) of its Duty Master ac motors. Product features of each motor are clearly outlined and explained for easy selection of the right motor for every application. With the photos and descriptions of the motors is a detailed description of the production facilities and procedures used to manufacture these motors.

(104) AUTOMATION SYSTEM: The Reeves AIRtrol bulletin, issued by *Reliance Electric and Engineering Co.*, explains how drive speeds of machines and processes can be automatically controlled and regulated by pneumatic instrumentation. Drawings and descriptions show how the unit can be applied to control liquid level, line pressure, process temperature, constant flow, steam pressure, and motor loading. A number of pneumatic pressure control systems can be applied; these include manual remote, automatic open loop, automatic closed loop, and multi-unit systems.

(105) RARE EARTH CHEMICALS: *Vitro Chemical Co.*, a division of *Vitro Corp. of America*, has issued a revised 1961 edition of its brochure containing complete technical information about thorium, yttrium chemicals, metals, and alloys of the rare earth group of elements. These 14 elements are achieving considerable commercial importance in missile development, glass polishing, ceramics, and atomic energy. The eight-page brochure also lists detailed properties and chemical analysis of more than 50 products, several of which are now available for the first time on a commercial scale.

(106) MOBILE RADIO: *General Electric* has published bulletin ECR-793, entitled, "Complete Control with Two-Way Radio." It describes how mobile communications integrate operations of any business where vehicles are used for sales, delivery or supplies. All of a company's vehicles can be put on a single system or set up on separate networks, depending on the needs of the individual business.

(107) ADJUSTABLE PRESSURE SWITCHES: A folder describing a leak-proof, adjustable and differential pressure switch for use in fluid systems operating at up to 250 psi has been made available by *Pall Corp.* Bulletin E6 includes photographs and drawings of the switch together with a description of its construction and operation, optional variations, and available accessories. The Deltadyne switches covered by this bulletin are adjustable within the differential pressure range of 0.125 to 16 psi. They incorporate the principle of magnetic transmission of the pressure differential to the actuating mechanism, eliminating mechanical linkages and sealing problems. The bulletin also contains data on applications, porting, and the wide variety of fluids with which these switches may be used.

(108) WHAT DO YOU READ?: An informative booklet entitled, "Why, When and How to Read Business Publications" has been made available by the *Fred Wittner Co., Inc.* This 10-page booklet intelligently treats the problem the modern business man is faced with as a result of the ever-growing, though important, business and trade publications. The author, Fred Wittner, gives some valid hints on how to develop efficient reading habits in order to extract the maximum benefit from the business press.

(109) CONTRACT RESEARCH: "The Administrative Controls of Contract Research for Industry," a descriptive statement on the procedures and characteristics of contract research, has been prepared by *Battelle Memorial Institute.* The statement describes the balance of administrative controls between the sponsor of a project and the research institute engaged, under contract, to conduct the study. As reported in the statement, the sponsor retains basic control over the objective, scope, costs, and timing of research, but is relieved of technological administration. Each of these aspects of administrative control is discussed briefly.

(110) SPEED MEASUREMENT SYSTEMS: *General Electric's* bulletin GEZ-3251 describes G-E's complete line of ac and dc tachometer generators and indicators. The bulletin relates information of instruments' applications, calibration, accuracy, and method of selection. Specifications, schematic drawings, and photos of the measurement systems are also included.

(111) MACHINERY DESCRIPTION: A 24-page brochure titled, "Nordberg Machinery for the World's Major Industries" which illustrates the variety of its products, has been released by *Nordberg Mfg. Co.* Products described in the brochure include: diesel, duafuel, and gas engines rated from 10 hp to over 12,000 hp for municipal and industrial power plants, pipe line pumping, oil well pumping, and marine propulsion; Symons gyratory and cone crushers; and Symons vibrating grizzlies and screens, gyra-disc crushers, grinding mills, kilns, and other machinery for processing ores and industrial minerals.

(*Continued on page 562*)

EMBIE JR. says—

If you want more information concerning the

Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A.

fill in your name and address on Reader Service Card (page 551) and **circle No. 100.**

New M-S-A® Pager gives you the convenience and flexibility of a telephone with the amplification of a loud speaker

Now, with one versatile communications unit, you can page key personnel over a loud speaker or converse semi-privately by phone. A flip of the switch on the new M-S-A Pager lets you do either.

Uses Existing Lines

The new unit is a completely self-contained, transistorized telephone. Individually battery-powered, these units utilize existing phone lines, and can be used in conjunction with most other telephones.

Simultaneous Paging

Ten or more Pagers can be installed on a single line. This makes it quite simple to page key men from a number of points . . . simultaneously. Once the man answers, a flip of the switch converts the Pager into a regular telephone for private or semi-private conversing.

24 Volts for Paging . . . 12 Volts for Talking

Two dry cell batteries provide the power source. And the power is expended only when the unit is in use, thus conserving battery life. Estimated battery life: 2 to 3 months on a 5% duty cycle.

Easy Installation and Maintenance

Weighing about 25 pounds, the M-S-A Pager can be mounted on a timber or a rib. All parts readily accessible with removal of four fastening screws which open the front half of the case. Transistors are vibration-proof . . . no filaments . . . so high efficiency, long life are assured.

For additional information, ask the MSA representative to call. And write us for helpful new product data bulletin.

Mine Safety Appliances Company, Pittsburgh 8, Pa. In Canada: Mine Safety Appliances Co. of Canada, Ltd., 500 MacPherson Avenue, Toronto 4, Ontario.

MSA

Circle No. 28 on the reader service card.

DATA
FOR MINE AND MILL

(Continued from page 560)

(112) GRILLES SPECIFICATIONS: An architectural anodized aluminum grilles specification manual has been published by *Klemp International.* The manual provides product specifications on the wide choice of standard geometric patterns, dimensions, and colors on which this material is available. Outstanding industrial, commercial, and housing design use in new construction and modernization are shown. The construction details for such applications as a curtain wall, a solar screen, or a walkway are illustrated with technical drawings.

(113 CHEMICAL FEEDER: The mechanism and operating principles of the type "G" Gravimetric chemical feeder are discussed in Bulletin 260 issued by *INFILCO Incorporated.* This general purpose feeder handles all dry chemicals normally used in water and waste treatment, whether the chemicals are in powder, granule or lump form up to ¾-in. diam. Its finely balanced weighing mechanism gives an accuracy of plus or minus 1 pct of the set rate over an operating range of 20:1.

(114) AIR TOOLS: *The Power Tool Co.* has released a 48-page catalog illustrating its line of contractor and mining air tools for use in tunnels, mines, quarries, and for factory maintenance. Catalog No. 46 contains diagrams detailing tool features and gives complete specifications on all models.

(115) CONDULETS FOR HAZARDOUS AREAS: *Crouse-Hinds* Condulets and the National Electrical Code are discussed in Bulletin 2722, a 60-page publication detailing the applications of condulets in hazardous locations. Code Articles 500-503 and 510-517 are quoted, along with recommendations for condulets meeting the various Code requirements. More than 300 product photos, installation photographs, and drawings illustrate this bulletin.

(116) PIPING MATERIALS: *Trans-Plastics Corp.*, a technological organization recently formed to market a complete line of pipe, pipe fittings, sheet, and engineered fabrications made of such corrosion-resistant materials as PVC, Polyethylene, and ABS, has released the Introductory section to its 80-page Engineering Manual. The eight-page introduction tells a comprehensive story of the company, its policies, history of the materials, its engineering and fabrication services, its products, and product characteristics.

(117) BELT CONVEYORS: An 11-page brochure covering detailed specifications and prices for a range of conveyors from 9 to 99 ft long, 18 to 36 in. wide, to a maximum capacity of 500 tph, has been issued by *Finco, Inc.* The brochure, complete with charts on bulk material classifications, belt capacities and speeds, also includes various plan drawings of 3 to 10 hp and 15 to 30 hp terminals.

(118) COUPLINGS: Bulletin 4100, issued by *The Falk Corp.*, describes their complete line of torsionally resilient Steelflex couplings. Additional coupling types, dimensions for larger sizes, and easier methods of selection are included. How their grid-groove coupling design protects connected machines against shock, vibration, and misalignment is also explained and illustrated. Charts and tables, appearing throughout the bulletin, contain up-to-date engineering data.

(119) CENTRIFUGAL PUMPS: Bulletin No. 721.6, issued by *Goulds Pumps, Inc.*, announces that new sizes have been added to their Model 3405 line on single stage, double suction centrifugal pumps. Thirty-four sizes are now available to provide capacities from 100 to 6400 gpm with heads up to 525 ft. A choice of grease or oil-lubricated bearings, wide degree of interchangeability of parts, availability in stainless steel and ductile iron, are among the many features of this group of pumps. Complete specifications, interchangeability chart, performance curves, and dimensions are also included in the bulletin.

(120) WEIGH FEEDERS: *Syntron Co.* has announced the publication of a weigh feeder machine catalog. The weigh feeders are designed for the accurate feeding of dry chemicals required in water filtration and in chemical and food processes. The weigh wheel gravimetric feeder, providing precise, steady feeding of bulk materials, is also featured. In addition, data is presented on the company's batch weigh plants for accurate, automatic weighing of multiple batches of various materials, used where carefully weighed batches must be measured out to true proportions.

(121) BIN FEEDERS: The development, construction details, and special features of the live bin feeders for metering all dry materials are described in a four-page technical bulletin issued by *Vibra Screw Feeders, Inc.* A partial list of more than 250 solid materials that have been metered by these feeders indicates their wide use in the chemical, petroleum, plastics, and many other industries. Metering rates are tabled from 0.12 to 8400 lbs per hr, and from 0.003 to 200 cu ft per hr with an accuracy of ± 1 pct.

(122) REFRACTORIES: *Harbison-Walker Refractories Co.* has released a brochure entitled, "Refractories: Nucleus of Industry" which deals with such subjects as: the raw materials used in making refractories; the contribution of refractories research to technological progress; refractories service to industry; mining of refractories; and quality control from blasting to batching.

(123) SOLID LUBRICANTS: A booklet published by *The Alpha-Molykote Corp.* discusses boundary friction and the role of solid lubricants to reduce friction and wear under heavy loads and at high temperatures. Bulletin 124 describes the major advantages of molybdenum disulfide solid lubricants—low coefficient of friction, natural affinity for adherence to metal surfaces, and pressure resistance beyond the yield of any metal.

(124) SAFETY COURSE: A series of six text booklets entitled, "Men and Motives in Safety Supervision" outlining a safety training course for industrial foremen has been issued by the *National Safety Council.* Each booklet is for a one hour training session for foremen. The foremen's manual tells how to set up meetings and apply the material to individual plant situations. The course offers practical instruction on ways a foreman can better understand his men and work with them toward safer, more efficient work practices.

New Films

The International Nickel Co. is offering two 16mm, sound and color films to interested technical, scientific, educational, and industrial organizations. The first film, "Mining For Nickel," gives a clear picture of the underground workings of a mining operation. The film interweaves whole sequences of animation to clarify the methods pictured. This animation, coupled with the live-action photography, presents a comprehensive picture of the mining of nickel—from the search for, and method of locating the ore, through the basic development of a mine, to a coverage of the six different mining methods used by Inco to extract the ore.

The other film offered by Inco, "Milling And Smelting the Sudbury Nickel Ores," offers a complete presentation of the nickel milling and smelting operation. In addition, this film describes the history and formation of the Sudbury Basin deposit, analyzes the components of the material, and shows how the efforts of Inco's research engineers, technicians, and staff have combined to discover better methods of mining, and greater uses for the ore. To obtain these films, write to: *Rothacker Inc.*, Time & Life Building, New York 20, N. Y.

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WHAT SYMBOLIZES PRESTIGE

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To belong to the Society of Mining Engineers of AIME is a measure of the high regard and admiration in which each member is held by his fellow professionals and the Public. It is a mark of Prestige.

The seal of the Society of Mining Engineers of AIME is the symbol of that prestige—recognized wherever mining men gather.

In response to many requests from members, the jewelry illustrated on this page has been designed to permit SME members to wear the Society's seal.

Executed in antique gold with the lettering, hammer, chisel, and derrick in bold relief, these handsome pieces of fine jewelry will be numbered among your prized possessions. Only SME members may acquire them.

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Those who are recognized are remembered.

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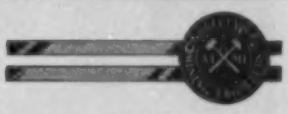

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Lapel Button	$2.60	$3.10	$ 5.10	$ 6.30	
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Tie Chain	5.40	5.90	7.90	9.10	
Tie Tac	2.80	3.30	5.30	6.50	
Charm	2.65	3.15	5.15	6.35	
Tie Bar	4.70	5.20	7.20	8.40	
Bracelet & Charm	4.10	4.60	6.60	7.80	
				Total	

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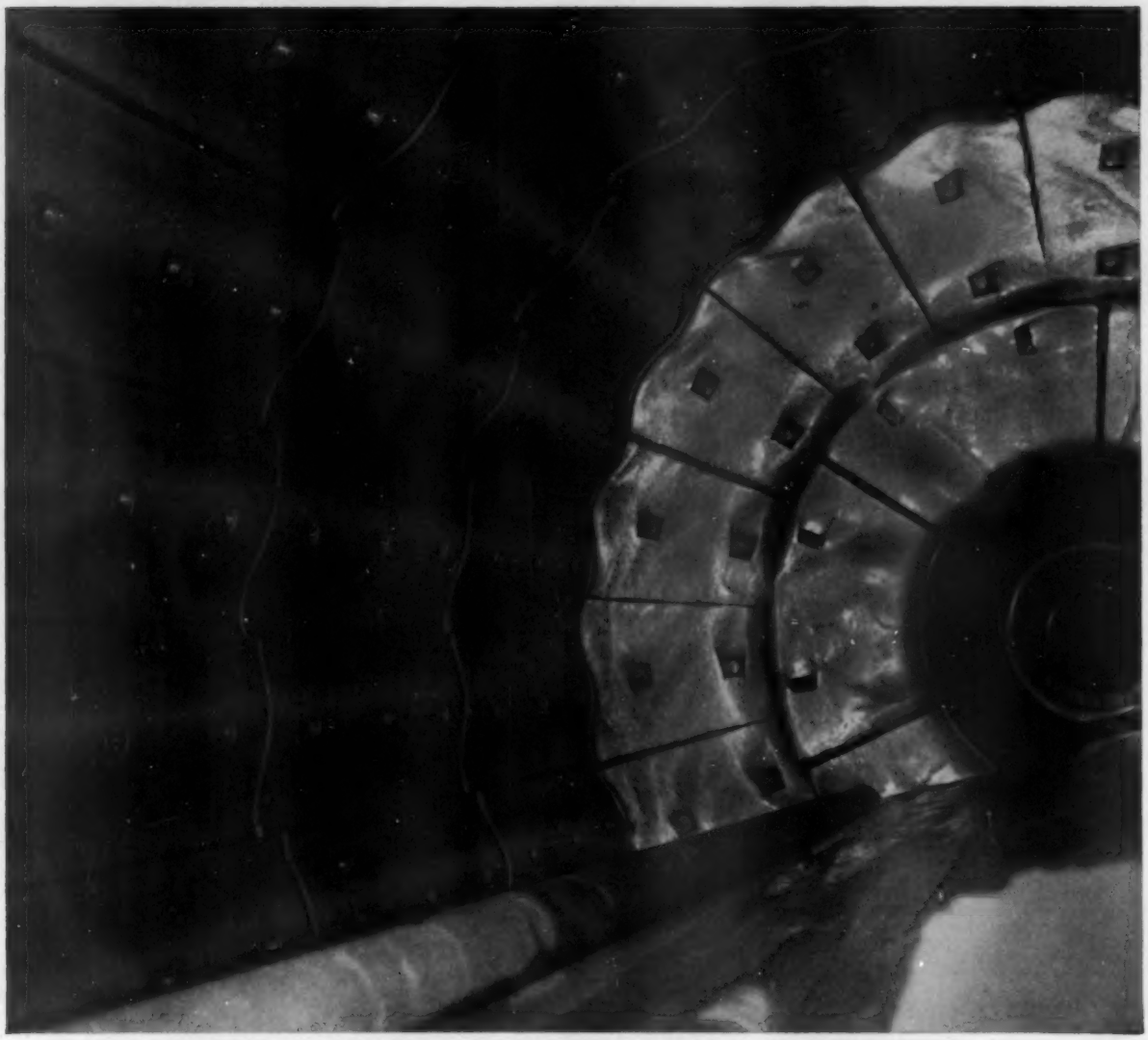

The Ni-Hard iron liners in this rod mill have saved over $16,000. Cost per ton of ore dropped to 0.89 cents, compared with 2.50 cents per ton for manganese steel liners formerly used.

In this rod mill 2 years . . .

Ni-Hard liners save over $16,000

Two years ago, Canadian Malartic Gold Mines installed Ni-Hard* nickel-chromium white cast iron liners in their rod mills. A profitable move: in grinding 933,000 tons of abrasive gold ore, Ni-Hard iron liners have saved over $16,000.

2 years' service, only 20 hours downtime. This cost-cutting performance is due to the outstanding abrasion resistance of Ni-Hard iron. Not only is its structure as hard as fully hardened steel, but it contains firmly embedded hard carbides which help it withstand particularly abrasive punishment.

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Contact your Ni-Hard producer and arrange to try a set of Ni-hard liners in your mills. He can also give you valuable information on this wear-resistant nickel-alloyed cast iron for other parts used in ore processing equipment — such as feed spouts, pipe elbows and fixtures, slurry pump liners, impellers and wear plates.

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THE INTERNATIONAL NICKEL COMPANY, INC.
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NI-HARD

NICKEL MAKES CASTINGS PERFORM BETTER LONGER

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MINING engineering REPORTER

Anaconda Reports New Chile Copper Find

Discovery of a 50-million-ton copper oxide orebody near the Chuquicamata copper mine in Chile, was reported by Anaconda Co. If the ore is amenable the find may prolong the life of the present oxide treatment plant at the Chuquicamata mine, where oxide reserves are being depleted. The company said the new ore grades about 1 pct Cu. Anaconda is investigating the possibility of expanding the concentrator to work large reserves of sulfide ore when the oxides are exhausted. The company is also studying plans for an electrolytic copper refinery at the port of Chanaral. The plant would be used to process ore from the El Salvador mine and possibly from other mining companies in Chile. El Salvador output is presently treated in the U. S.

Amax Sells Control of Mexican Units

American Metal Climax Inc. sold its controlling interest in its Mexican subsidiaries, Compania Minera de Penoles, S. A., and Compania Metalurgica Penoles, S. A. Under a new Mexican law, foreign mining operations must be at least 51 pct owned by Mexican nationals. The companies, which work mines, a lead smelter, and a lead refinery will be consolidated by the Mexican investors into a new company, Compania Metalurgica Mexicana Penoles, S. A.

Joint Zinc Venture Agreement

Mining and milling of a zinc deposit owned by American Zinc, Lead & Smelting Co. near New Market, Tenn., will be conducted by Tri-State Zinc Inc. under terms of a new pact. Recent drilling by Tri-State confirmed an estimated deposit of at least 20 million tons. The mill is expected to be completed by the summer of 1962 and will have a capacity of 2800 tpd of ore and this will later be increased to 3600 tpd. The mine is to be ready for 2400-tpd production in the following summer. Excess mill capacity will be used in the interim for milling American Zinc ores from nearby mines. Both companies are wholly owned subsidiaries; American Zinc Co. of Tennessee owned by American Zinc Lead & Smelting Co.; Tri-State by Consolidated Gold Fields of South Africa Ltd.

Carbide Granted $100 Million Uranium Contract

Union Carbide Corp. uranium mills at Rifle and Uravan, Colo., are permitted to deliver more than 12 million lb of concentrate to the AEC under terms of a new contract which covers the period April 1, 1961, to December 31, 1966. Existing separate contracts which would have expired early in 1962 were replaced by the new agreement. An annual delivery limitation specifies that Carbide may deliver 3 million lb of U_3O_8 a year, of which no more than 2.5 million lb may be milled from ores controlled by the company. The per-pound price for oxide delivered before April 1, 1962, will be $8.41; thereafter, to termination of the contract, $8.00 per lb.

Domestic Coal for U. S. Bases in Europe

Coal for use by the U. S. armed services in Europe will be purchased only from companies obtaining the fuel from the U. S., as long as the price is not over 25 pct higher than European coal, says a new Government directive. In addition to aiding domestic coal producers, the decision is expected to reduce the annual dollar outflow by $2.9 million.

MINING engineering REPORTER

New Zinc Cutbacks Announced

Another reduction of slab output at two smelter plants and suspension of mine operations at the Flat Gap property in Treadway, Tenn., were announced by New Jersey Zinc Co. Smelter production will be reduced 1500 tons a month; Flat Gap mine output had been at the rate of 25,000 tons of concentrates annually.

Amax to Invest $40 Million at Climax

Over the next five years American Metal Climax will invest nearly $40 million to ready the Climax, Colo., molybdenum mine for maximum production. New development work will include preparation of the third level and work on surface and other supplementary facilities.

Kennecott Plans Basic Research Program

A new research program aimed at the acquisition of fundamental knowledge and stressing solid state physics will be begun shortly by Kennecott Copper Corp. F. R. Milliken, new company president, said that in contrast to the applied research pursued by the company and which may produce immediate financial benefits, basic research "is essentially long range in nature but has tremendous potential rewards." Location of a center for the research program and expenditure plans were not revealed.

Hanna Begins Commercial Sale of Oregon Nickel

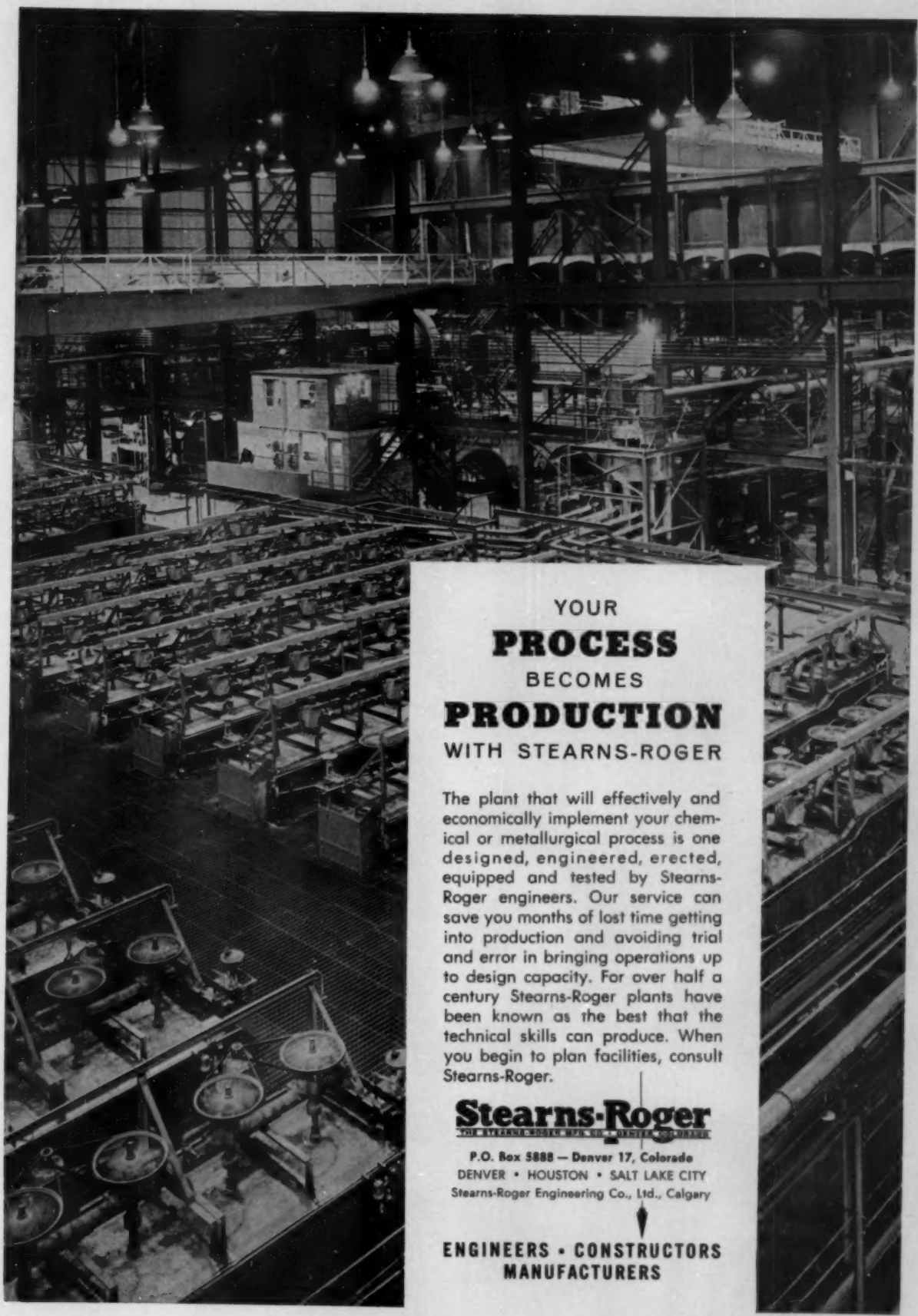
Hanna Mining Co., operator of the U. S.-financed nickel smelter at Riddle, Oreg., has acquired the facility under terms of an agreement with the federal government and has recently begun selling ferro-nickel on a commercial basis. Originally built at a cost of $22 million at the Hanna-owned nickel deposits in the Cascade Mountains, the smelter was erected to lessen U. S. dependence on imported nickel. In return for plant financing, Hanna was required to sell 125 million lb of ferro-nickel to the U. S. stockpile and then was to be allowed to buy the smelter for salvage value of $1.7 million. Terms of the agreement were fulfilled and the plant acquired but some question has arisen in government circles concerning the low sale price. The General Accounting Office believes additional payments to the Government should have been specified if plant operation became commercial.

Copper Price Climbs, Zinc Drops

The price of refined copper rose in two 1¢ increments to 31¢ a pound in May after a lengthy period of steadily improved buying. Refined metal deliveries in April were highest for any month in the year. Prices for two high grade zincs dropped ½¢ a pound because of sluggish sales and heavy stocks.

Canadian Firm Trades Copper for Japanese Financing

Rights to buy output of Bethlehem Copper Corp. Ltd., in Vancouver, have been purchased by two Tokyo firms, Sumitomo Metal Mining Co. and Sumitomo Shoji Kaisha Ltd. The Japanese firms have agreed to buy $500,000 in Bethlehem shares and will lend $5 million at 6% interest to be repaid in copper concentrate. In 1960 the two companies bought $350,000 in shares of the Canadian firm. Bethlehem will ship to Japan some 250 million lb of copper over a ten-year period starting December 1, 1962.



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The plant that will effectively and economically implement your chemical or metallurgical process is one designed, engineered, erected, equipped and tested by Stearns-Roger engineers. Our service can save you months of lost time getting into production and avoiding trial and error in bringing operations up to design capacity. For over half a century Stearns-Roger plants have been known as the best that the technical skills can produce. When you begin to plan facilities, consult Stearns-Roger.

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molten sulphur

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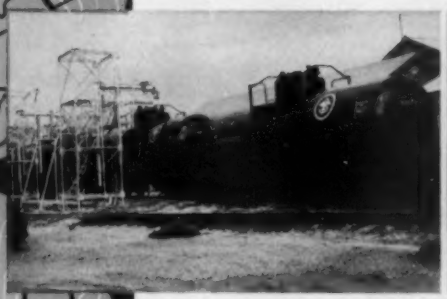

Beaumont, Texas is the shipping point for practically all the TGS tonnage of molten sulphur sent to the eastern half of the United States. *BUT* instead of waiting for deliveries measured in days TGS customers can rely upon these four regional terminals and get their supplies in much faster time.

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CYANAMID

Reagent News

ore-dressing ideas you can use

Colorado plateau plant tests show:

AEROSOL® C-61 and OT

Surface Active Agents improve Leaching, Thickening and Filtration

Recent reports from leading uranium producers indicate remarkable success for AEROSOL Surface Active Agents in uranium ore treatment.

AEROSOL OT-75%, an easy-to-handle liquid, improves the penetrating action of leach solutions, reduces acid consumption, lowers ultimate tailings and provides other beneficial side effects. AEROSOL C-61, a water soluble paste, reduces moisture content in final yellow cake filtration.

Plant A treats 480 tpd by acid leaching with 85 lb/ton H_2SO_4, 1.5 lb/ton Na_2ClO_3 following this with solvent extraction using a tri-fatty amine. An additional 240 tpd are treated by carbonate leaching with 30-40 lb/ton Na_2CO_3. AEROSOL OT-75% is added to both circuits at rate of 0.1 lb/ton. Pregnant liquors from both circuits are combined and uranium recovered by NaOH precipitation. Use of AEROSOL OT has reduced acid consumption by 30 lb/ton (115 vs. 85 lb/ton).

Plant B treats 300 tpd by acid leaching with 217 lb/ton H_2SO_4, 2.7 lb/ton Na_2ClO_3 following this with resin-in-pulp (RIP) recovery of uranium. AEROSOL OT at the rate of 0.1¢/ton lowers ultimate tailing and increases overall recovery by 2%. In addition, due to AEROSOL OT, efficiency of sand-slime separation circuit has improved in both cyclones and CCD classifiers. A decrease in sliming over on resins and a somewhat improved flow through the baskets has been noticed.

Plant C treats 450 tpd by acid leaching with 45 lb/ton H_2SO_4, 1.5 lb/ton Na_2ClO_3 and 0.18 lb/ton AEROSOL OT-75%. Uranium is then recovered by solvent extraction with an amine. Estimated saving of $0.80/ton in acid has been realized due to AEROSOL OT. In addition, while AEROSOL OT is added to leach circuit, enough carries through to eliminate the nuisance of scum from #1 CCD thickener.

Plant D treats 5000 tpd by acid leaching with 300 lb/ton H_2SO_4, 3.0 lb/ton Na_2ClO_3, followed by uranium extraction with a tri-fatty amine. C-61, added to the yellow cake slurry at 5 lb/ton, has lowered moisture 5 to 6% (50 to 44%).

AEROSOL OT-75% has also shown benefit in acid leaching of copper and zinc and has found wide application as a filtration aid for improving cake quality and reducing cake moisture in filtration of sulfide concentrates.

AEROSOL Surface Active Agents may lead to savings at your operation. Send for samples today.

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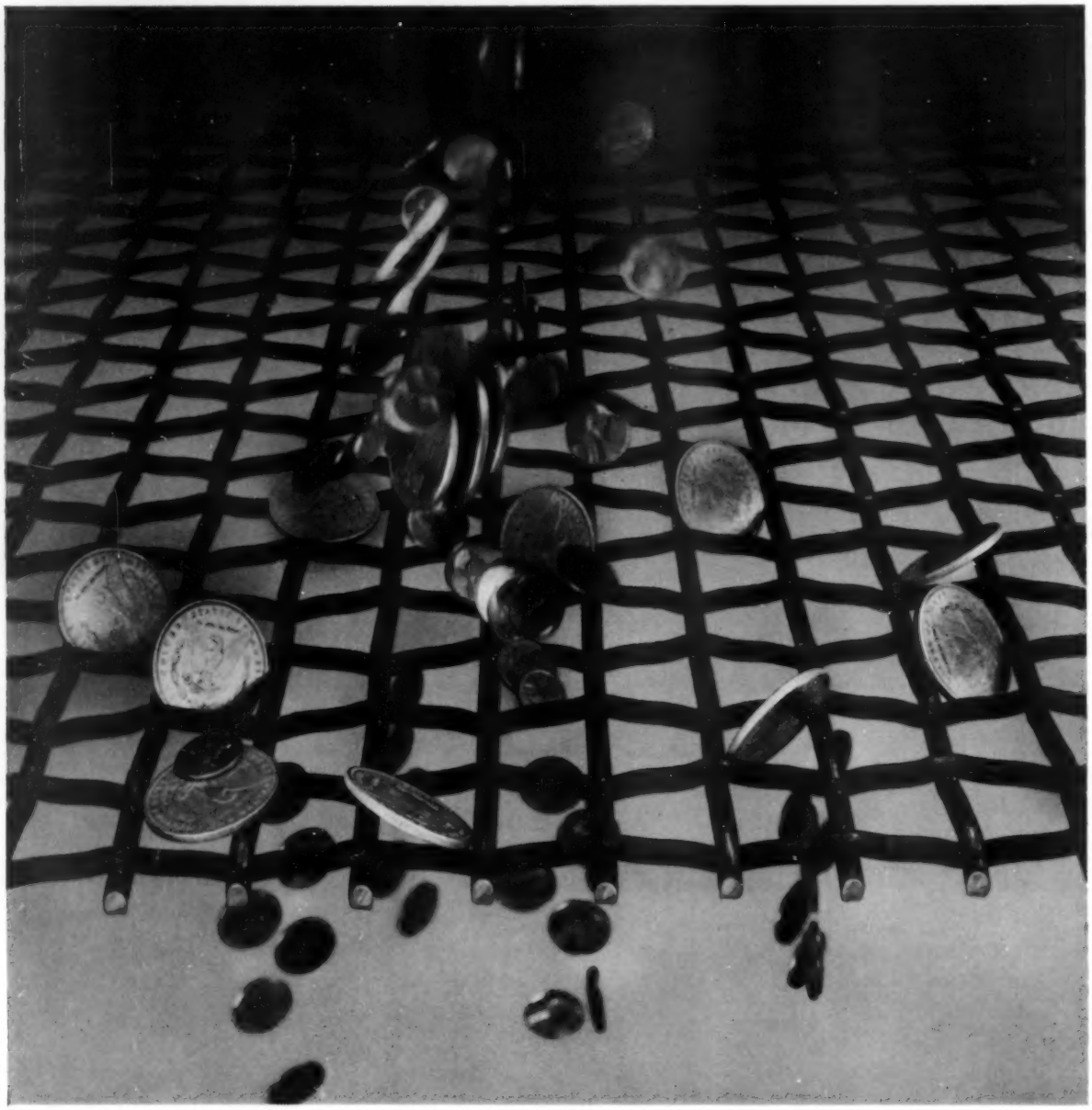

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MINING engineering **DRIFT**

Class of '61—The future looks bright!

Apparently we are not going to be invited to address any of the graduating classes of our mining colleges this year. However, we can take advantage of the spirit of the season in this column.

Graduation addresses should be inspirational and contain a modicum of advice. Taking the last part first, we have a suggestion from our own early experience *à propos* to the new graduate employed at a going mining operation. Being asked to design a sawdust burner several years ago, we presented a structure with a material list selected from the AISC handbook. The work was not accepted and we were referred to the scrap pile for building materials. Moral—given a structural design problem, you will impress the boss by checking available materials before laying out the job.

Another thought is that the young engineer should be able to pick up and move to another property if the needs of his company require it. You may be forgotten if you fail to take these opportunities as they come.

For inspiration we turn to the industry and the world situation. Mineral exploration is substantial. There are new mining projects in the development stage. The price of copper is on the up-swing. The variety of mineral raw materials required by industry is greater than ever before. The technical problems of mining and processing present challenging targets for the new engineers. The foregoing remarks are good material and often used by the graduation orator in those years when they can be made with sincerity—we think that this year is one of them.

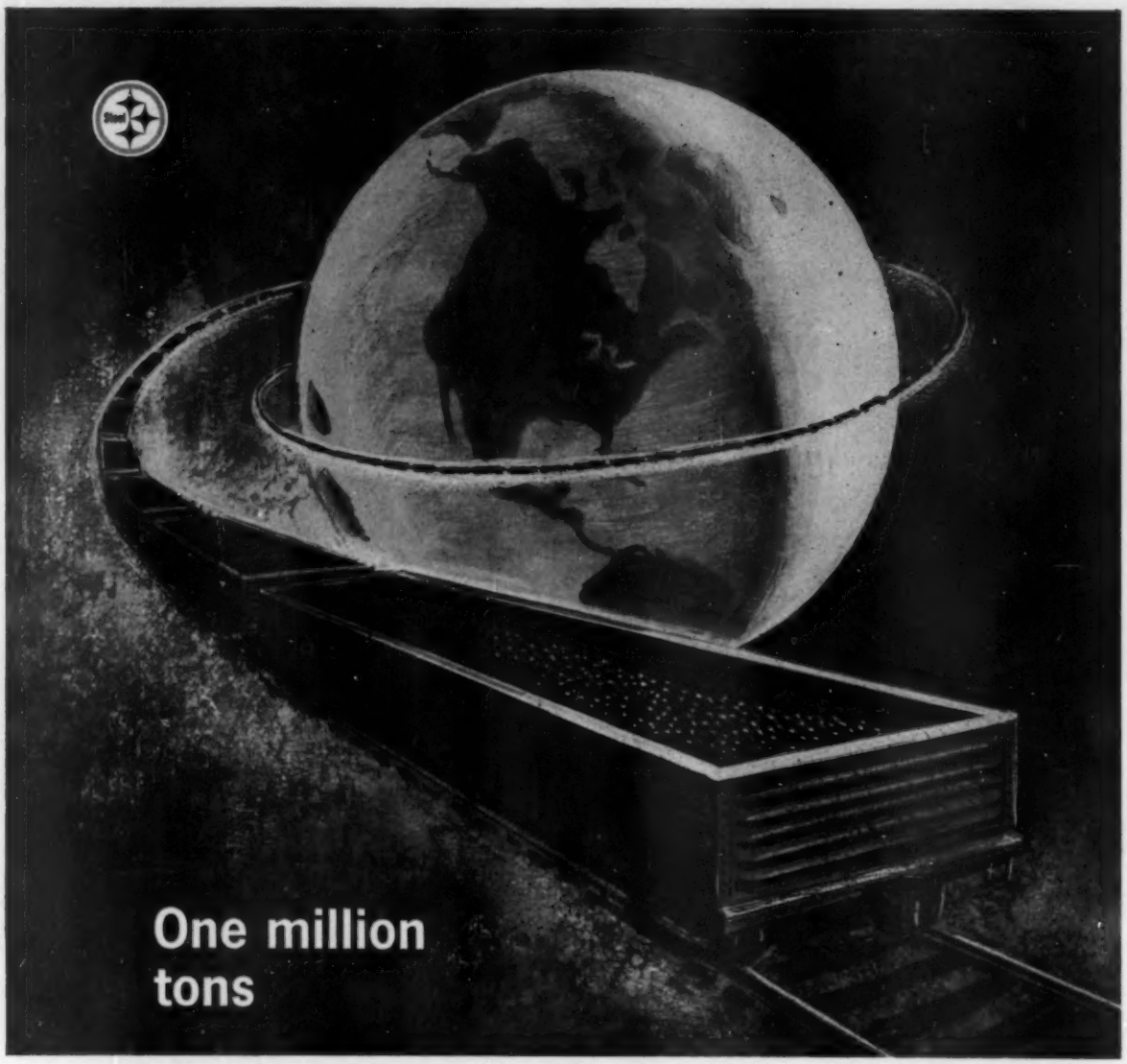
But what can we say to the young graduate who is thinking of the world mining field in which his predecessors wandered far and wide relatively unrestrained by the types of political forces so prevalent today?

The world of colonialism in which our traditional mining man found his successes has crumbled slowly over the last 50 years, but precipitously in the last ten. Colonialism has been replaced by self-determination of peoples divided from each other by arbitrary political boundaries. This movement has restricted the area in which mining men may seek their fortunes. We have remaining Canada, Australia, and South America not to mention our own country.

Advances in science have accelerated with the social movement. Today we literally reach for the moon. We think that the scientific revolution with its ever increasing need for variety and quantity of minerals will continue at an accelerated rate. The social movement will evolve with the same acceleration from today's *nationalism* to a concept of *internationalism*.

In our new accelerated time table, it will not be long before the mining graduates of today will be active again on a similar scale to their forebears when the concept of harmony of nations is impressed by the need for raw materials and the training of non-productive nations which possess them.

To the graduates of 1961, the mining fraternity offers a welcome and an assurance that each man can carve out a career according to his ambitions.



have earned customer acceptance

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Grinding Balls

ARMCO Sheffield Division

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BUNKER HILL'S CONCENTRATOR

EQUIPPED TO PROCESS 3000 TONS OF LEAD-ZINC ORE DAILY

by NORMAN J. SATHER

The history of the Bunker Hill mine dates back to August 26, 1885, when Noah S. Kellogg found the outcrop of the Bunker Hill orebody on the hillside of Milo Gulch above the present town of Wardner, Idaho. A small concentrator was erected in 1886, and before the railroad came, the mine output was transported by mule teams to the head of navigation on Coeur d'Alene Lake. After ten years of production, an interest was purchased in the Tacoma smelter at Tacoma, Wash., to which the entire output was shipped. In 1916 and 1917, a modern lead smelting plant and refinery was erected, and a modern electrolytic zinc reduction plant was built in 1927-1928 by the Sullivan Mining Co. which was 50 pct owned (and now totally owned) by the Bunker Hill Co.

The first concentrator, a 100-tpd capacity plant, was built in 1886 near the Reed Tunnel in Wardner. The treatment consisted simply of crushing ore to 2 in. and then to ½ in. through rolls in closed circuit with a bucket elevator and trommel screen. The undersize was further sized in trommels to 10 mm and 3 mm. Oversize from the latter was treated in Hartz jigs. The 3 mm undersize was classified in crude hydraulic classifiers furnishing sands to sand jigs, the overflow being dewatered in a long *V* tank which supplied sands to a Cornish buddle and to Frue vanners. The concentrates were of excellent grade, old records showing assays of 69 pct lead and 29 oz. of silver per ton. Tailings were high inasmuch as the provision for treating the slimes was inadequate.

Since the erection of the first mill, the Bunker Hill plant has gone through many changes and improvements. In succeeding years, the flowsheet was enlarged somewhat with Huntington and Chilean mills, vanners, tables, ball mills, and flotation cells being progressively added. In the transition period to the present day practice, the object was not only to improve the equipment for better mechanical performance, but to add new equipment whenever practicable so as to improve both grade and recovery of the product at a lower cost.

The history of flotation at Bunker Hill dates back to 1913 when experimental work was done in a cell in which the pulp was circulated through a centrifugal pump set outside the cell and discharged against a baffle in the cell. The cell was built

N. J. SATHER, Member of SME, is Superintendent of Concentration, The Bunker Hill Co., Kellogg, Idaho.

with a spitzkasten, and the quiet zone in the latter tended to let the froth break down before it got to the overflow weir. To remedy this situation, a belt drag with light metal flights was arranged for drawing off the froth over a ramp in each cell. Recovery of lead was not as high as present day practice, but was so much better than the vanners that the cells were multiplied gradually to eight cell units. The mill men called them "mud hens". Flow between the cells was controlled by a weir, which determined the pulp level in each cell. These early machines were called "Bunker Hill" machines. The tailings were later treated in pneumatic scavenger flotation machines in a series, producing concentrates for retreatment in the Bunker Hill cleaners as well as the final tailings.

This system of flotation served with minor changes until the Fahrenwald machine was developed at Bunker Hill during the period from 1921 to 1925. In 1925, the Fahrenwald flotation machine gradually replaced the Bunker Hill machine, although the Hearing pneumatic scavengers for retreatment of the tailings from the Fahrenwald machines were retained in the lead section until 1928. The use of the Hearing pneumatic machine for cleaning the rougher concentrates was begun in 1924.

In 1941, plans were made for remodeling and modernizing the concentrator, the goal being a modern concentrator employing the latest equipment and milling practices. The old wooden building was to be replaced by a steel and concrete structure.

Shortly after preliminary work got under way, the United States entered World War II and the demands for metals increased. To meet this requirement, the management decided to increase the capacity of the concentrator to 1800 tpd. This was accomplished in record time by the construction and operation of a sink-float plant. Installation of this plant was the first step in the general plan for modernization. In 1947 the concentrator (including the sink-float plant) was enlarged to handle 3000 tpd. Milling operations today are at the rate of 2300 tpd, five days per week. During 1959, 453,000 tons of ore was beneficiated.

The Bunker Hill concentrator is in three sections: the crushing plant, a 3000-ton capacity storage bin, and the concentrator building. The crushing plant is of wood design with a "gunnite" coating on the exterior. The storage bin is of reinforced concrete, measuring 50 ft in diameter and 24 ft in height. The main concentrator building, which houses the grinding, flotation, thickening, and filtering sections is 265 ft long and 168 ft wide.

CRUSHING PLANT

Transportation: From the underground No. 1 Hoist pocket at the mine site, the ore is transported by electric trolley trains approximately two miles to the crushing plant, the last 1000 ft being above ground. The cars, 18 to a train, hold 4.2 tons each and are of hopper bottom design. These cars are known as "Big Sam's", a name given them by an old-time blacksmith.

Primary Crushing: The ore from the bottom dump cars is unloaded into ore bins at the primary crusher plant. The bins consist of six sections with a total live load capacity of 1400 tons. From the bins, the ore is transferred by 11 chute feeders onto a 42-in. conveyor which carries the material under a 65-in. diam magnetic separator for removing hammer heads, etc. The ore is then fed by a 42-in. conveyor to a 4x8-ft single deck screen containing 2x3-in. slotted holes. Oversize is sent by gravity to two No. 5 Chalmers and Williams gyratory crushers with a 12-in. opening and 2½-in. discharge.

A 24-in. belt, 60 ft long, takes the primary crusher discharge, together with the primary screen fines to two secondary Allis-Chalmers screens. These latter screens are both single deck lowhead types, one measuring 4x14 ft and the other 5x14 ft. Both are equipped with 1-in. square mesh No. 3 wire screens. Wood scalpers, 20-in. long on discharge end of screens, scallop off any large pieces of wood.

Secondary Crushing: Secondary crushing is done by two 4-ft Symons standard crushers set at ½-in. opening. The discharge is conveyed by a 24-in. belt to a 4x10-ft lowhead-type vibrating screen, also equipped with a 1-in. square mesh wire screen. All undersize material from the three screens is then sent by 24-in. conveyor to the 3000-ton capacity storage bin.

The bin is discharged at seven points by means of Hardinge constant weight feeders. A 20-in. conveyor carries the ore from the bin to four 350-ton capacity ball mill bins in the concentrator building. These bins are kept filled at all times.

CONCENTRATOR PLANT

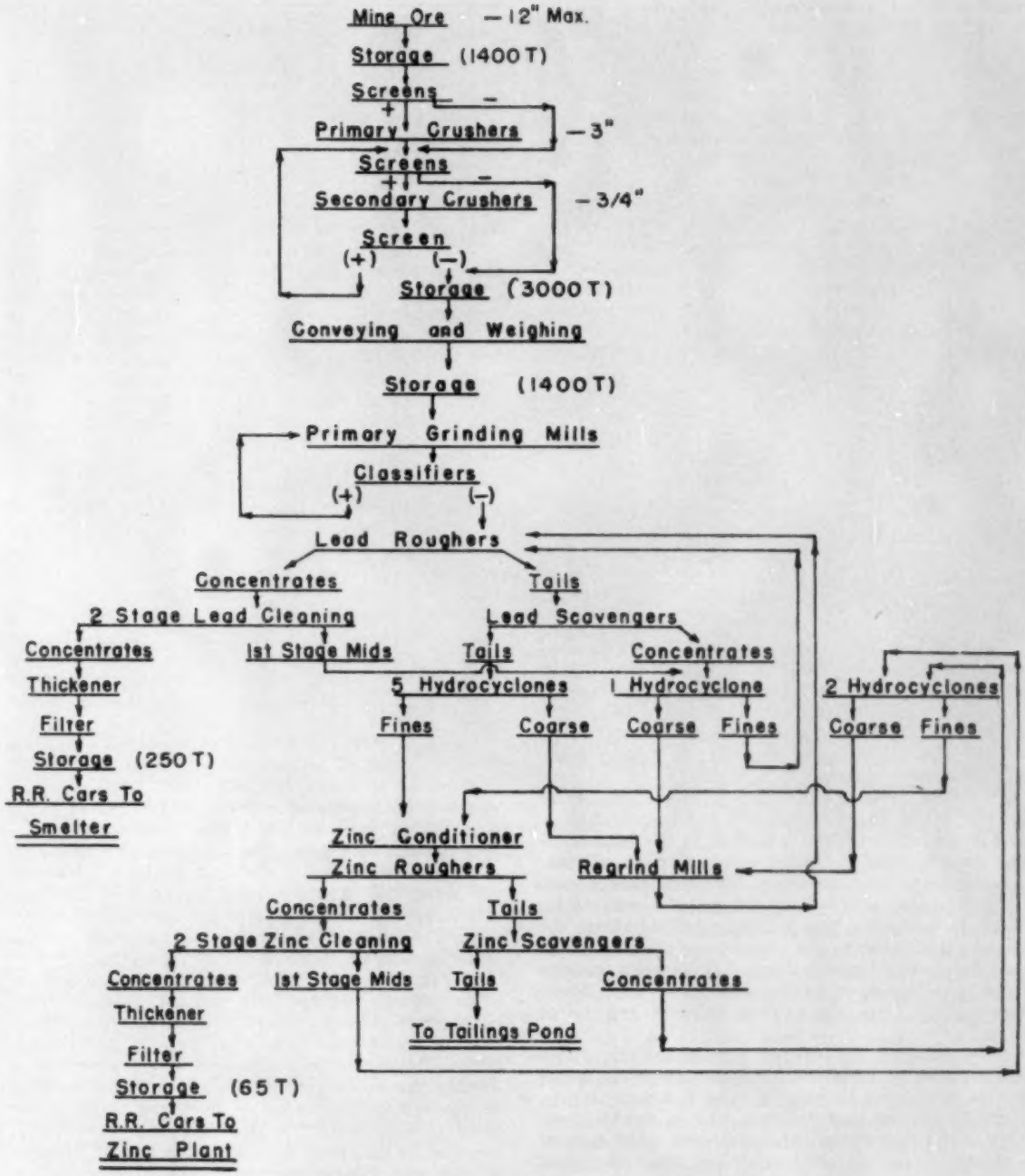
Grinding: Primary grinding is accomplished in three 10½x8-ft ball mills made by Union Iron Works. Each mill, operating at 16 rpm (68 pct of critical speed), is in a closed circuit with 48-in. Akins duplex spiral classifier. An 8x3-ft Hardinge ball mill in closed circuit with a Dorr duplex type D 6x21-ft classifier is employed as a standby grinding circuit.

Table I lists the ball mill product; the basic operating data and specifications of the primary ball mills are as follows:

Ball mill size	10½ x 8 ft
No. of ball mills	3
Balls	3 to 4-in. Molly Cop; 1 to 1 ration charge
Ball load	76,000 lbs
Ball mill speed	16
Pct critical speed	68
Hp	400
Ball consumption	1.58 lbs per ton
Weight of liners—shell	30,990 lbs
Type of liner—shell	Ni-Hard
Type of liner—ends	Ni-Hard
Liner service—shell	320 days
Liner consumption—shell	0.11 lbs per ton

Table I. Cumulative Screen Analysis of Ball Mill Product

Mesh	Ball Mill Feed Pct by Wt	Ball Mill Discharge Pct by Wt	Class. Sands Pct by Wt	Class. O'Flow Pct by Wt
+¾	9			
+½	26			
+⅜	39			
+¼	49	—	—	—
+4	57	0.9	5	—
+6	64	2	6	—
+8	69	—	—	—
+10	73	—	—	—
+14	77	6	11	—
+20	79	9	15	—
+28	82	15	23	—
+35	84	24	38	0.4
+48	85	38	54	4
+65	87	49	67	11
100	88	60	77	22
150	89	67	83	32
200	91	72	87	41
325	92	79	91	53
−325	8	21	9	47
	4.5 pct Moisture	80 pct Solids		50 pct Solids



Simplified flowsheet of the Bunker Hill concentrator.

The classifier overflow is screened on 18x72-in. Denver vibrating screens with No. 14 gauge steel punched plate screens having 4-mm openings. This removes wood pulp which is carted away in wheel barrows by the operator. The flow goes to two centrifugal pumps in parallel which then send the feed to the lead flotation section to form a coarse lead concentrate.

All the lead and zinc middlings after regrinding, in addition to some flotation return and clean-up thickener underflow, are returned to the lead flotation section via 6-in. Allen-Sherman-Hoff pumps. This return tonnage can vary due to changing operating conditions and ore characteristics. The returning zinc becomes deactivated by conditioning with original feed and reagents.

Regrind Circuit: The lead flotation tailings from the rougher section are pumped to a hydrocyclone section. The pulp is classified with the sands going to three Hardinge 8x3-ft ball mills for regrinding, and the cyclone overflow is sent to the zinc flotation section. The ball mill discharge is returned to the lead flotation section. The hydrocyclone section is composed of nine 6-in. cyclones discharging in parallel from a 12-in. diam header. Usually, only six cyclones are in operation with the remaining

three on standby. Each cyclone operates at a pressure of 22 lbs which is obtained by an 8-in. Allen-Sherman-Hoff pump operating at 760 rpm.

Middling Regrind: The lead flotation middlings, combined with the lead flotation cleaner tailings, is pumped to a 6-in. cyclone. The underflow returns to one of three 8x3-ft Hardinge ball mills for regrinding; the cyclone overflow plus ball mill discharge is sent back to the lead flotation section.

The zinc flotation middlings plus zinc flotation cleaner tailings from the first cleaner section, is also sent to a 6-in. cyclone. The cyclone underflow goes to one of the three regrind ball mills and then to the lead flotation section. The overflow from the cyclone returns to the zinc conditioner. Screen analysis and densities of the regrind circuit are given in Table II with specifications of the regrind ball mills as follows:

Ball mill size	8 x 3-ft
No. of ball mills	3
Balls	1 in., carbon (charge 16 ton)
Ball mill speed	22.6 rpm
Pct critical speed	83
Hp	200
Ball consumption	0.69 lbs per ton
Type of liner	Ni-Hard
Weight of liners	25,270 lbs
Liner service barrel	1417 days
Liner consumption	0.01 lb per ton

Final Grind: The overall grind is based on fineness of the final zinc flotation tailings due to a large circulating load going through the hydroclone section and regrinding circuit thus returning to the original flotation section. The final tailings average about 61 pct minus 200 mesh, 1 pct of plus 48 mesh, and about 48 pct at minus 325 mesh.

Flotation: With the classifier overflow density of 50 pct solids in the primary grinding circuit, a coarse lead concentrate is floated in the lead flotation section. This is carried out in two 14-cell, 48-in.Galigher flotation machines. The concentrate from the first eight cells goes to a bank of 4-cell, 36-in. flotation machines. The middling product from the last six cells goes to the regrind circuit along with lead flotation cleaner tailings. The cleaner concentrate is recleaned in another bank of 4-cell, 36-in. flotation machines, the tailings going to regrind as above.

Lead flotation tailings are conditioned for about two minutes in a two-unit conditioner before going to the zinc flotation section. The flotation is performed as in the lead flotation cells except the product of the first six cells only of each bank goes to a 4-cell, 36-in. flotation machine. The last eight cells produce a middling product which is returned to the regrind circuit along with the first cleaner flotation tailings. The cleaner concentrate goes to another bank of 4-cell, 36-in. flotation machines and the cleaner tailings are then returned to the zinc conditioner.

Table II. Regrind Mill Products (shown in Cumulative Percentages)

Mesh	Cyclone Feed, Pct Wt	Ball Mill Feed, Pct Wt	Ball Mill Discharge, Pct Wt	Cyclone O'flow
+35	0.9	2.7	0.2	0.6
+48	4.9	13.7	1.2	2.8
+65	11.0	28.4	3.0	6.4
+100	21.6	47.3	7.6	13.4
+150	32.2	61.5	15.9	21.8
+200	42.3	72.3	29.2	30.8
+325	55.7	83.1	50.6	45.6
−325	44.3	16.9	49.4	54.4
Density	52 pct Solids	77 pct Solids	77 pct Solids	44 pct Solids

Table III. Reagent Consumption, Lbs Per Ton of Ore

	Lead Flotation	Zinc Flotation	Total
Sodium Cyanide	0.092	—	0.092
Zinc Sulfate	0.23	—	0.23
Xanthate—Z4	0.054	0.101	0.155
Barrett No. 4	0.08	0.013	0.093
Methyl Amyl Alcohol	0.02	0.007	0.027
Copper Sulfate	—	0.15	0.15
Lime	—	0.59	0.59
Separan	—	0.001	0.001
Soda Ash	0.147	—	0.147

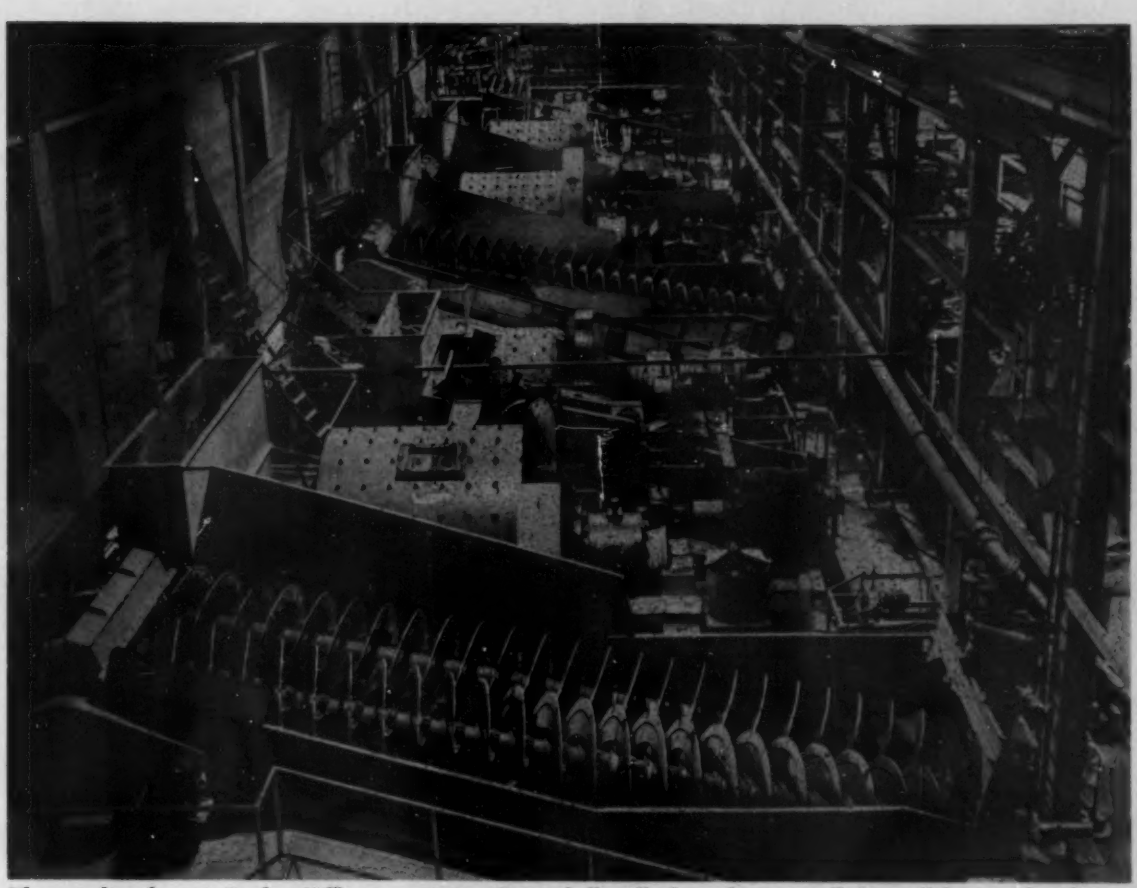
The flotation reagents used are somewhat standard. Barrett No. 4 oil and methyl amyl alcohol are mixed in ratio of 3:1 respectively and used as standard frother throughout the flotation circuit. Xanthate, soda ash, sodium cyanide, zinc sulfate, and the Barrett alcohol mix are all added to the product from the primary ball mills. Soda ash is added to bring pH for lead roughers up to 7.2 Soda ash is also added to the first lead flotation cleaner to assure pH of being 7.2 to 7.4. Sodium cyanide and zinc sulfate are added to first and second lead cleaners. Copper sulfate plus Xanthate and frother mix is added to the zinc conditioner ahead of zinc roughers. In addition, Xanthate and the frother mix are added to the middling section of the zinc rougher flotation circuit. Sodium cyanide is added to regrind ball mills. Lime is added to first zinc flotation cleaner to raise the pH to 12.0. Reagent consumption is shown in Table III.

Thickening and Filtering: The final lead concentrate assaying 65 pct lead, 41 oz. silver and 6.5 pct zinc is sent to a 40x10-ft thickener. The underflow goes via bucket elevator to an 8x14-ft Oliver drum filter which produces a lead filter cake with a moisture content of 9.4 pct. The thickener overflow plus all floor washings go to a second 40x10-ft thickener, the underflow of which joins the regrind ball mill discharge and thence goes to the lead flotation section. The thickener overflow is returned to the water system for reuse in primary grinding.

The final zinc concentrate has an average content of 54 pct zinc, 1.5 pct lead, and 5.0 oz. silver. This concentrate goes to a 40x10-ft thickener from which the underflow goes to another 8x14-ft drum filter, and the overflow to a concrete waste water pond outside the concentrator building for final settling of any solids. The overflow from the waste water pond is discarded. The zinc thickener overflow is handled in this manner due to the use of Separan in the zinc thickener circuit. The filter cake has a moisture content of 13.0 pct.

Ore Loading: Lead concentrates are conveyed from the filter to a 250-ton capacity circular reinforced concrete bin. The bin has seven 14x20-in. openings equipped with adjustable feed gates through which the concentrate is fed onto three parallel 24-in. conveyors. The conveyors are mobile so the loading into the 75-ton capacity Bunker Hill-type, air operated, side dump railroad cars is quite rapid.

The filtered zinc concentrates are conveyed from the filter to a 65-ton capacity bin. This bin has two 14x20-in. openings equipped with adjustable feed gates through which the concentrate is fed onto a 30-in. mobile conveyor. Seventy-ton Union Pacific railroad cars are used to transport the zinc concentrates to the zinc electrolytic smelter.



The grinding bay at Bunker Hill's concentrator. Seven ball mills have been installed parallel to each other. A 20-ton crane is presently employed to discharge 1 ton of grinding balls into each ball mill every 43 hours.

TAILINGS DISPOSAL

The concentrator tailings, which contain 32 pct solids, is pumped 3800 ft to a 40-acre tailings pond where a pipe is employed to distribute the sands. This pipe is a 12-in. wooden stave type on a 0.7 pct grade. The pipe surrounds the pond leaving each side pipe lateral open on the far western end for final discharge of fines. From a distribution box, the operator can flow the tailings pulp to either north or south pipe lines for the distribution of the sands. The sands are dispersed through 1-in. diam holes spaced at 15-ft intervals. After the settlement of solids, the clear water is decanted to waste. Tailings are impounded to prevent contamination of the Coeur d'Alene River.

METALLURGICAL CONTROL

The daily tonnage is determined by a daily weightometer reading on the conveyor transferring ore to the ball mill bins. No accurate weighing is made to each ball mill although occasional checks are made by supervision to determine tonnage to each mill.

Tonnage sent to the grinding circuit is kept at a maximum through the use of a Hardinge electric ear control installed near the underside of the ball mill. Corrections are made as the liners wear, providing additional tonnage through ball mills. Classifiers are equipped with a Bunker Hill-Bailey Meter Density control and recorder. Operational control is maintained by taking hourly density samples and pH readings at designated points.

Samples for control are kept at a minimum. Hand samples are taken hourly on lead and zinc flotation concentrates and sent to the Assay Laboratory each day for assaying. Samples of final zinc tailings are taken automatically during each shift. The feed sample is taken automatically on ball mill feed, ground in a 3x3-ft ball mill and belt drag classifier circuit. The overflow is automatically sampled and composited for a daily mill feed assay. The filter concentrate of lead and zinc are hand-sampled each hour from a cut from the concentrate conveyor belt. A sample of each is sent to the Assay Laboratory every 24 hours for testing, and these assays are used for car shipments for that particular day. Weighted composites of all products are made each day and assayed monthly for check on daily average assays. The lead and zinc concentrate shipments are weighted, moisture taken, and sampled at the smelter operations. Sample pulps are assayed both at the smelter and concentrator assay departments and assays are compared for final settlement. A final metallurgical balance is calculated from settlement weights and assays, in addition to final tailing assay and known mill feed tonnage.

A calculated "mill feed assay" is checked with weighted "mill feed assay" and composite "mill feed assay." These checks have been found to be reasonably close. Daily calculations are made using daily assays and mill feed tonnage to derive the tonnage of concentrates of lead and zinc. These calculations have no bearing on final records but are used only for a check analysis on mill results.

MARGINAL ANALYSIS

ITS APPLICATION IN DETERMINING

CUT-OFF GRADE

by EDWARD L. VICKERS

Over the years, the pure theorist in economic analysis has accumulated a formidable array of facts in bringing his subject matter under control. Business managers and mining engineers are aware of the theorist's weapons, but the question of applying them to the mastery of practical problems seems hardly feasible, especially in view of the almost innumerable variables plaguing the everyday scene in the mining enterprise.

One such sophisticated tool of long-standing in the theorist's arsenal is *marginal analysis*. Equally long-standing for the operating company and valuation engineer is the problem of defining the cut-off grade—the point below which a mineral resource ceases to be economically amenable to extraction. In other words, *what part of a mineralized body of rock is ore and what is waste?*

Fortunately, after many years, the business man has seen the need to bridge the gap between the "pure" form of economics and the problems confronting the business enterprise. The aim of this paper is to perhaps aid in building that bridge.

The cut-off grade can be a very elusive line of demarcation. But properly applied, the technique of marginal analysis can aid in telling us at what point to stop extracting low grade mineralized rock; it demonstrates, in fact, the amount of rock which can be extracted from an ore body. That point of cut-off is defined in this analysis as the *point which maximizes total profits for the ore body*, given a specific cost-revenue situation. What marginal analysis does, quite simply, is to bring into focus the impact on that relationship between cost and revenue when the level of activity is varied. In this analysis the level of activity which we must vary is merely the *reserve factor*.

In essence, we are dealing with a marginal concept in that we expect to add lower and lower grade ore until total profits cease to increase. Each unit of material which is added to the higher grade ore, when mined, produces increasingly higher cost per pound. At some point the up-scaling of additional costs must assuredly outweigh the benefits received from the larger tonnages of the lower grade ore. Hence, the solution of such a problem refers itself immediately to one of classical marginal analysis.

Before proceeding further, it is advisable to arm ourselves with a few basic definitions:

Average Revenue Per Pound of Metal: Average revenue is the total price received for a product divided by the number of pounds sold.

Average Total Cost Per Pound of Metal: Average total cost is the total operating cost (i.e., variable cost plus fixed cost) incurred in producing a product, divided by the total number of pounds produced.

Variable Cost: Variable cost is that total cost incurred in producing a product which tends to vary with the level of output, divided by the total units produced.

Fixed Cost: Fixed costs are total costs for that outlay of factors which do not vary with the level of output, remaining the same regardless of the level of recovery.

Marginal Revenue: Marginal revenue is the additional revenue obtained when one additional unit is sold. If the total output increases by one unit, the resulting change in total revenue is marginal revenue.

Marginal Cost: Marginal cost is the total additional cost that is incurred by the production of one additional unit.

Level of Recovery: Level of recovery, as used in this discussion, is the total number of pounds of metal actually extracted from a given body of ore; thus, it is a function of the grade.

Rate of Recovery: Rate of recovery is the annual production rate of the mining operation expressed in tons.

The analysis will proceed in the following sequence: first, the framework on which marginal analysis is built is reviewed; second, this framework is modified to fit the solution of our problem; and finally, a hypothetical situation is envisaged. Necessary variables are isolated and fitted into the theoretical framework. The solution of the problem will then follow out of this logical structuring of variables.

Before an analysis can be carried out, certain basic assumptions upon which the analysis will be based must first be understood. The first of these assumptions is that *the firm's objective is to maximize the total possible profits available from the orebody*. More precisely, the firm will produce the *average grade of ore* which provides the *largest margin between total revenue and total cost*. The determination of the lowest grade that can be extracted at which total profits are maximized is thus the *cut-off grade*. In addition, it is assumed that the price of the product is a constant, known by the firm. This price is uninfluenced by the company's own sales, and further, this firm can sell at that price any amount it produces.

To more clearly illustrate the form of analysis proposed, Fig. 1 will be employed. The first issue is to define the position of the marginal revenue and average cost per pound line. Under the condition of pure competition (also assumed for the sake of control) these two elements coincide and follow a horizontal line at the given price level per unit.

Average costs classically will follow a pattern as shown in Fig. 1. At very low levels of recovery they fall rapidly due to the absorption of the fixed cost element in increasingly larger number of units of output. At a certain output level this curve will reach a minimum; then it reverses and swings upward. Graphically, this reflects the *point of diminishing returns*, and the addition of more units of output results in higher overall costs per unit. The lowest point of this curve defines the maximum value of one unit of output; however, this is *not* the optimum level of operation. Maximum total profits from the ore body defines a firm's optimum level of recovery. This point is conclusively established when we follow logically, step by step, through cost-revenue relationships by the means of marginal analysis.

Marginal costs will first cross the average cost curve at the latter's minimum point. Then the marginal cost curve continues to rise at increasingly higher levels of output until it ultimately crosses the marginal revenue curve. The relationship between average costs and marginal costs is not mere coincidence. They show a general mathematical relationship wherever there is a decreasing, then increasing relationship between two variables. In the marginal analysis model, it is invariably true that, first, the average cost curve falls so long as the marginal curve is below it; second, that the average cost curve rises and continues to rise so long as the marginal curve is above it; and third,

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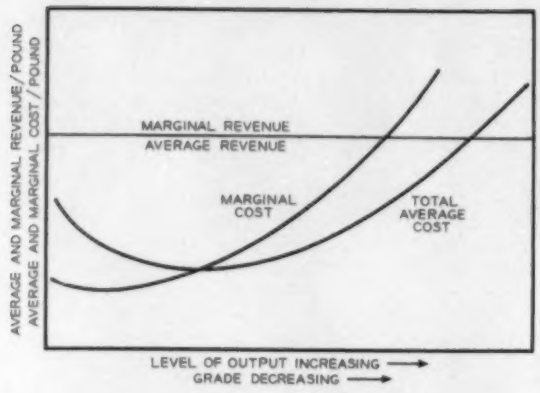

Fig. 1.

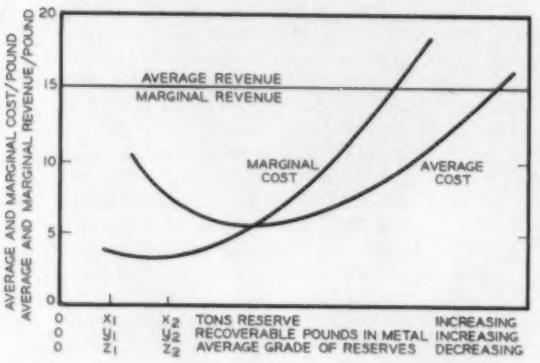

Fig. 2.

that the marginal curve, therefore, intersects the average curve at the precise point where the latter is horizontal—that is, where the average cost per pound is a minimum. The firm's equilibrium position of maximum profits is found at the level of output where *marginal cost* and *marginal revenue* are equal. At lower outputs the increment in revenue is greater than the increment in cost as output is increased by one unit, but at higher outputs the marginal cost exceeds the marginal revenue with a consequent reduction in total profits*.

Returning to the basic problem under analysis (i.e., the definition of *cut-off grade*) let us see how this theoretical approach applies. First, it is necessary to change the label of Fig. 1 as indicated on Fig. 2. The analysis will also require one additional assumption—namely, the rate of recovery (i.e., tons produced per annum) will be held constant for all possible *levels of recovery*. Although there is a definite inter-relationship between the two, it will be assumed that rate of recovery is a predetermined factor and only the level of recovery (or grade produced) need be varied. For purposes of this study, the ordinate of Fig. 2 measures an increase in ore reserves.

Referring to Fig. 2, the marginal and average revenue line represents the sales price of the metal and is a horizontal line for any amount of metal produced. The abscissa measures the average and marginal cost per pound of metal produced. The ordinate cost per pound of metal produced. The ordinate depicts the reserves of a hypothetical ore body. As reserves are increased, the grade logically is decreased, and therefore the amount of recoverable metal climbs; but the rate at which it increases is defined by the grade distribution in the orebody. (The use of grade distribution will be discussed on the following page.)

Average total costs per pound of metal decrease to a point, level off, and then increase. Average total costs are, of course, a function of tons mined. As the reserves are increased by the lowering of the grade, the amount of contained pounds of metal per ton of ore mined decreases; consequently, there is an increase in the total cost per unit. Marginal costs will behave in a similar manner, but they will rise at a different rate. The incremental addition of lower grade ore produces less and less revenue per ton, and at the same time, incremental costs continue to rise—a point of equilibrium between marginal revenue and marginal cost finally occurs. The additional pounds of ore now fail to provide additional net revenue, and the level of optimum recovery is reached. Thus, the cut-off point is defined.

EXAMPLE OF MARGINAL ANALYSIS

The orebody envisaged is a porphyry copper deposit with known ore reserves of 265 million tons, having an average grade of 0.849 pct copper. It is assumed that the orebody will be mined by block caving operation at a production rate of 15,000 tpd. The overall cost of production (variable and fixed cost), excluding depreciation, is $4.00 per ton, a price which will hold constant throughout the life of the property. In view of the fact that rate of recovery is held constant, capital investment will be considered as an unvarying value; and it is not affected by the grade of ore produced. An example of this would be our plant with a capacity of 15,000 tpd, regardless of the ore grade. The capital investment required by this mining project is arbitrarily assumed to be approximately $60 million.

It is recognized that many assumptions contained in the example are not in accordance with actual practice. They are made, however, for simplicity of presentation. Under any actual condition the variation in cost, metal price, capital investment,

* For a more detailed discussion of the above statements, the reader is referred to any good text on economic analysis; such as "Economic Analysis" by Kenneth Boulding.

Table I. Grade Distribution

Grade Interval (Pct Copper)	Grade Midpoint (Pct Copper)	Percentage Frequency Distribution	Tonnage Distribution (x 000)	Cumulative Tonnage (x 000)
1.50-1.35	1.425	7.0	18,550	18,550
1.35-1.20	1.275	8.0	21,200	39,750
1.20-1.05	1.125	10.0	26,500	66,250
1.05-0.90	0.975	13.0	34,500	100,700
0.90-0.75	0.825	17.0	45,050	145,750
0.75-0.60	0.675	21.0	55,650	201,400
0.60-0.45	0.526	24.0	63,600	265,000

Table II. Metal Distribution

Grade Interval (Pct Copper)	Grade Midpoint (Pct Copper)	Cumulative Tonnage (x 000)	Tonnage Distribution (x 000)	Metal Distribution (x 000)	Cumulative Pounds (x 000)	Average Grade (Pct Copper)
1.50-1.35	1.425	18,550	18,550	528,675	528,675	1.425
1.35-1.20	1.275	39,750	21,200	540,600	1,069,275	1.360
1.20-1.05	1.125	66,250	26,500	596,250	1,665,525	1.257
1.05-0.90	0.975	100,700	34,450	671,775	2,337,300	1.160
0.90-0.75	0.825	145,750	45,050	743,325	3,080,625	1.056
0.75-0.60	0.675	201,400	55,650	751,225	3,831,900	0.951
0.60-0.45	0.525	265,000	63,600	667,800	4,499,700	0.849

Table III. Operating Analysis

Avg Grade (Pct Copper)	Reserve Tons (x 000)	Copper Available Lbs (x 000)	Revenue—30¢ per Lb (x 000)	Operating Cost, $4.00 per Ton (x 000)	Depreciation (x 000)	Net Income Before Taxes	52 Pct Federal Income Tax (x 000)	Depletion—15 Pct of Gross Revenue (x 000)	Net Income After Taxes (x 000)	Mine Life—15,000 Tpd, 350 Day per Yr	Present Value of Cash Flow (x 000)[2]
1.425	18,550	528,675	158,602	74,200	60,000	24,402	6,344	12,201[1]	18,058	3.53	51,410
1.360	39,750	1,069,275	320,783	159,000	60,000	101,783	27,906	48,117	73,877	7.57	82,295
1.259	66,250	1,665,525	499,658	265,000	60,000	174,658	51,890	74,949	122,768	12.62	93,685
1.160	100,700	2,337,300	701,190	402,800	60,000	238,390	69,270	105,179	169,120	19.18	92,501
1.056	145,750	3,050,625	924,188	583,000	60,000	281,188	74,131	138,628	207,057	27.76	83,752
0.951	201,400	3,831,900	1,149,570	805,600	60,000	283,970	73,832	141,985[1]	210,138	38.36	65,714
0.849	265,000	4,499,700	1,349,910	1,060,000	60,000	229,910	59,777	114,955[1]	170,133	50.47	44,495

[1] 50 pct limit applies.
[2] Present value computed at 10 pct *speculative* rate and 6 pct *redemption* rate. Speculative rate is the return an investor expects to receive on his invested capital. Redemption rate is a safe rate of interest to allow recouping of invested capital throughout the lifetime of a wasting asset. The discount rates utilized in these calculations have been arbitrarily selected, but they are believed to be in accord with the attitude of modern mine managements.

etc., can easily be injected. The only factor that must be held constant for this particular analysis is rate of recovery. A similar analysis can be carried out, however, by varying rate of recovery while holding the total recovery constant; the basic principles existing here would still hold true.

The first step in the analysis is to determine the grade distribution of the reserves. This is most easily accomplished by the use of simple statistics. One method would be to randomly sample the assay values from various parts of the orebody used in reserves calculation; from these samples the frequency distribution within the various grade intervals can be determined. For the orebody in question, Table I presents the results of such a statistical study.† Other techniques may prove better suited for a particular orebody, but a quick statistical study can usually reveal the general pattern of the grade distribution. On the basis of Table I, it is a simple mathematical process to prepare Table II which represents metal available in the various grade intervals. From data contained in Table II, all raw materials needed for the calculation are available. Fig. 3 is a graphic presentation of the grade distribution for the orebody.

Table III presents the basic operating analysis used in deciphering the result of mining various grade intervals of ore. The picture depicted here is a straightforward, miniature profit and loss statement, showing the impact of extracting lower and lower grade reserves. Profits, after taxes, are seen to rise constantly until an average copper grade of 0.951 pct is reached; then a reverse trend occurs, lower earnings being represented by the lower grade reserves. This table actually tells us the range in which the maximum profits are obtained, but a final step in analysis is needed to reveal the true significance of this range.

By using the raw material of Table III, it is now possible to present a marginal analysis of the hypothetical orebody. The application of this data to the basic theoretical framework is made in Table IV. Reserves are arranged, as in Table III, in order of descending grade. The incremental element of lower grade ore reserves are injected in the analysis. To further facilitate defining where the cut-off grade lies, grade interval and grade midpoints of the incremental ore is also included. From this data the incremental pounds of contained metal can be easily calculated.

The total cost and total revenue can be taken directly from Table III (*total cost* representing operating cost plus depreciation, and taxes). The difference between total cost at any given level and the level immediately preceding it represents the incremental (marginal) cost incurred in producing the lower grade units of ore. By definition, the marginal cost is equivalent to the incremental cost divided by the additional pounds produced. A similar analysis holds for marginal revenue. Note that the marginal revenue is constant for all levels of output, an assumption which was made in the beginning of the analysis.

A review of the results indicates that the marginal cost and marginal revenue are equal somewhere between the grade midpoints of 0.825 and

† The statistical analysis employed here is not critical to the analysis itself and is presented merely to indicate the source from which the material used is derived.

Table IV. Marginal Analysis

Avg Grade (Pct Copper)	Reserve Tons (x 000)	Grade Interval (Pct Copper)		Lbs of Copper Available (x 000)	Total Revenue (x 000)	Total Cost (x 000)	Incremental Cost (x 000)	Incremental Revenue (x 000)	Avg Cost per Lb, ¢	Marginal Cost per Lb, ¢	Avg and Marginal Revenue per Lb, ¢
1.425	18,550	1.50	1.35	528,675	158,602	140,544			26.6		30
	18,500						106,362	102,181		19.7	
	21,200	1.35	1.20	540,600							
1.360	39,750			1,069,275	320,783	246,906			23.1		30
	39,750						129,906	178,875		21.8	
	26,500	1.20	1.05	596,250							
1.257	66,250			1,665,525	499,658	376,880			22.6		30
	66,250						155,180	201,532		23.1	
	34,450	1.05	0.90	671,725							
1.160	100,700			2,337,300	701,190	532,070			22.8		30
	100,700						185,061	222,906		24.9	
	45,050	0.90	0.75	743,325							
1.056	145,750			3,080,625	924,188	717,131			23.3		30
	145,750						222,301	235,382		29.6	
	55,650	0.75	0.60	751,275							
0.951	201,400			3,831,900	1,149,570	939,432			24.5		30
	201,400						240,345	200,340		36.0	
	63,600	0.60	0.45	667,800							
0.849	265,000			4,499,700	1,349,910	1,179,777			26.2		30

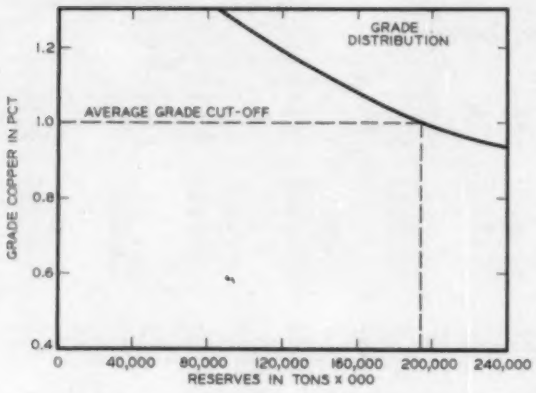

Fig. 3.

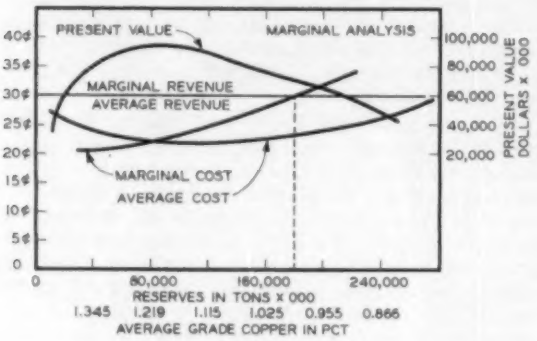

Fig. 4.

0.525 pct copper. In this range, as shown by Table III, the total profits have reached a maximum point.

To better illustrate the results obtained, it is advisable to construct Fig. 4. Marginal and average revenue are represented by the horizontal line drawn at an assumed market price level, 30¢ per unit. The average cost curve depicting our hypothetical data drops sharply in the beginning, reaching a minimum point at about 22.5¢ per lb, and then rises in a gentle slope as larger amounts of ore are made available. This curve defines the minimum cost per unit as well as the resulting maximum *unit* profit which is possible in our example. However, again our thesis is attempting to maximize *total* profits from the entire orebody.

The marginal cost curve drops slightly within the lower range of the analysis and then proceeds upward, intersecting the point of lowest average cost; finally, it crosses the marginal revenue curve at an average grade of 1.00 pct copper. This point is the level of recovery that will provide the maximum total profits from the ore body. To produce below this grade will leave ore in the ground that could be mined at a profit; whereas, beyond this grade, total profits are reduced, resulting from the fact that incremental ore is supplying less revenue than it costs to produce.

Cut-off grade can now easily be determined if we refer back to the basic calculation of grade distribution (Fig. 3 and Table II). The incremental ore producing an average grade of 1.00 pct fell within the range of grade intervals having midpoints of 0.825 and 0.675 pct. This is the range of the cut-off with its midpoint, 0.750 pct, representing the minimum grade that can be mined and still contribute to total profits.

TODAY'S VALUE OF TOMORROW'S DOLLAR INCOME

The cut-off grade has now been isolated (thanks to marginal analysis) within the limits of assumptions made at the beginning of this article. As a practical matter, the question may be asked, "What happens to the problem of *present value?*" In the analysis thus far we have focused only on the actual unadjusted dollar-and-cent element of the problem. We assumed at the outset that the company's objective was to maximize total profits. If, however, it is company policy to consider earnings as having significance only within a defined time limit, the level of recovery must be then adjusted to maximize *present value.* If, on the other hand, in view of the orebody having a long life, the company considers it to be of perpetual form of earnings, total profits in themselves mark the level at which the orebody should be exhausted. In the latter case, it is assumed that by virtue of its long life, $1.00 five years from now has an equivalent value to us then, as $1.00 today. To demonstrate the effect of present value on cut-off grade, a graphic presentation is shown on Fig. 4. Even if we alter our original assumption, therefore, and chose to discount the future value of earnings at a given rate, marginal analysis can still determine the point of cut-off. Further development, however, regarding which value is actually correct to consider as a base, is beyond the scope of this paper.‡

SUMMARY

The entire analysis presented is a special case of the application of marginal analysis to a common mining problem. The reader will most assuredly ask the question of what happens when rate of recovery is varied—a point having a high degree of interdependence in the selection of a cut-off. In some cases, the rate of recovery is fixed by the existing facilities, physical features, market conditions, etc., and it need not be a consideration. In this discussion only the level of recovery has been varied, yet, the same procedure can be utilized for various rates of recovery. If the situation demands, both factors can be varied simultaneously, but the results would have to be represented pictorally on a three-dimensional graph.

The use of marginal analysis is a powerful tool to the mining engineer in all cases where the level or rate of output are considered. In each case, the basic method is one of adding or taking away increments of ore; by definition, this is a marginal study. Coupling this technique with a statistical study of the ore reserves, a solution to the elusive mining problem of cut-off grade can be arrived at confidently within rigid, calculatable limits.

‡ For further information in "Present Value," see "Examination and Evaluation of Mineral Property" by Roland D. Parks (3rd Edition, 1949).

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GROUND SUPPORT

AT THE PITCH MINE

For several years, ground support at the Pitch uranium mine has been a serious headache to the management. The "moving" ground raised havoc with standard timber sets as well as steel sets. The author discusses this problem which has led to the adoption of heavy cribbing practices in drifts and raises.

by JAMES E. DUNN

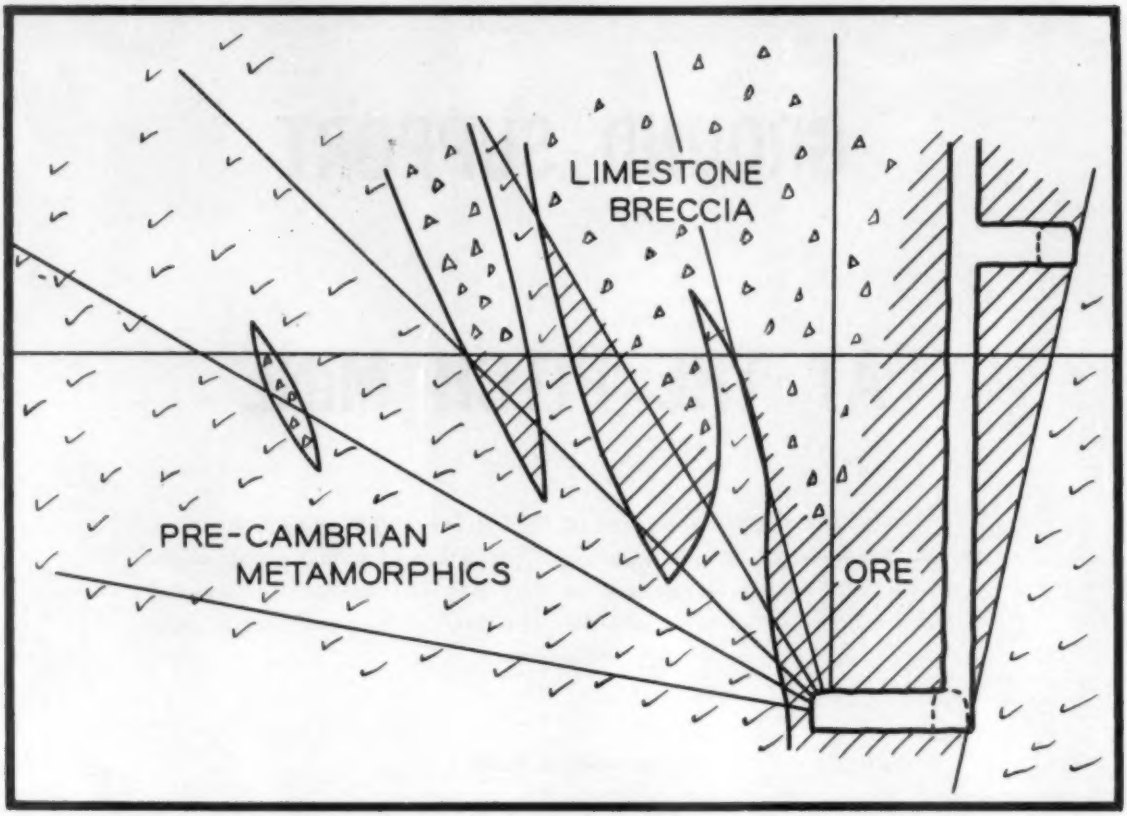
The Pitch mine, operated by Pinnacle Exploration, Inc., is located five miles southwest of Monarch Pass on the western slope of the Continental Divide, 30 miles east of Gunnison, Colo. The Pitch is a small uranium mine, but it presents a multitude of problems in every phase of the operation. Geology is complex; climatic conditions are rigorous; and ground pressures are extreme in some sections of the mine (See MINING ENGINEERNG, May 1961).

To handle the constant demands for timber in the mines, the company is taking all timber from the 5000-acre claim area. However, this will not be sufficient for long. Based on experience to date, one million ft of timber will be required for every 30,000 tons of ore produced. Douglas fir, Lodge Pole pine, and Engelmen spruce are used. Most of the Douglas fir goes into permanent openings and station timber. Spruce, when green, has strength enough for stoping as it is necessary to hold the ground for only a relatively short time.

Principal underground work to date is adjacent to a major thrust fault which is the contact between Precambrian schists and pegmatites and Pennsylvanian sediments. Known ore occurrences have been confined to brecciated limestone pendants of the Belden formation along this fault. At the ground surface, the fault is a sharp dividing line between Precambrian rocks and later sediments, but at varying distances below the surface the sediments wedge out in Precambrian metamorphics and intrusives.

J. E. DUNN, Member of SME, is Manager of Pinnacle Exploration Inc., Gunnison, Colo. This paper was presented at the Sixth Annual Uranium Symposium, May 1961, in Grants, N. M.

Start of timber failure on 339 sublevel. Note bow on posts.



Typical cross-section of a Pitch orebody. Some wedge-shaped blocks give evidence of being forced upward.

The exact width of the fault zone and the resultant pendants of limestone in older rocks is unknown, but it has been partially explored for distances up to 300 ft from the fault.

The presence of these limestone pendants in the fault zone is attributed to reverse movements on the fault subsequent to the initial thrusting, with sympathetic faults acting as glide planes between the sediments and older rocks. Introduction of uranium-bearing solutions occurred during or after the latest movements. A typical cross-section through one of the orebodies is illustrated in the above diagram.

Access to the mine is by an 865-ft long cross-cut, with main level drifting in the ore-bearing structure adding another 2000-ft of haulage way. Every square foot of ground in the mine requires support, and every set of timber in place to date (excepting part of the cross-cut) shows weight. The Pitch cross-cut was started December 1, 1959, and since then, approximately one-half of the original timber installed in the haulage way has had to be replaced at least one time.

The standard drift set employed at this mine is composed of 75-in. long, 10x10-in. fir caps; posts of green Lodge Pole timber 8½-ft long with a minimum 12-in. diam; and girts, commonly 6x8 in. Mud sills usually are not used. It is less costly in most cases to move the track and lower the bottom of the drift with a mucker than to do the same thing and replace broken mud sills at the same time. Posts are given enough batter so that they will come in very slowly and can be relieved before they break. Drifts are commonly driven with timber placed on 5-ft centers and reinforced by jump sets, bringing spacing down to 2½-ft centers. This is done by follow-up crews.

Development drifts within the limestone lenses also require timber, but they do not generally exhibit the tremendous pressures that occur in work areas adjoining Precambrian rocks or along the fault contact.

EARLY TIMBERING PRACTICES

One section of the Pitch cross-cut, which included the intersection of the orebody, exhibits greater than normal ground pressures. This area is about 180-ft long, is on the main haulage way, and must be held open for the life of the mine. It was originally timbered on 5-ft centers, but one 50-ft section was supported with 6-in. H steel beams in the form of a gothic arch. Both steel and timber required constant repair. The steel sets placed on 4-ft centers required more maintenance than did timber and had to be completely replaced after about eight months. Lagging was pinned back in this case on 2x4-in. blocks which transmitted enough pressure to deform the steel before blocks were crushed. The 180-ft section required the entire time of a two-man repair crew on the graveyard shift. Repair cost for the first year, including labor and supplies, totaled nearly $15,000 for the one short stretch.

During that year's repair work, much was learned about the ground. The area is under a great deal of plastic pressure and the rock is actually flowing. Under this condition, it will never form a natural arch to ease the pressure. This situation is illustrated in the section where steel sets were used. The rock is relatively hard, and when driving the original opening, it was difficult to break. The back sloughed constantly and required immediate timber. During

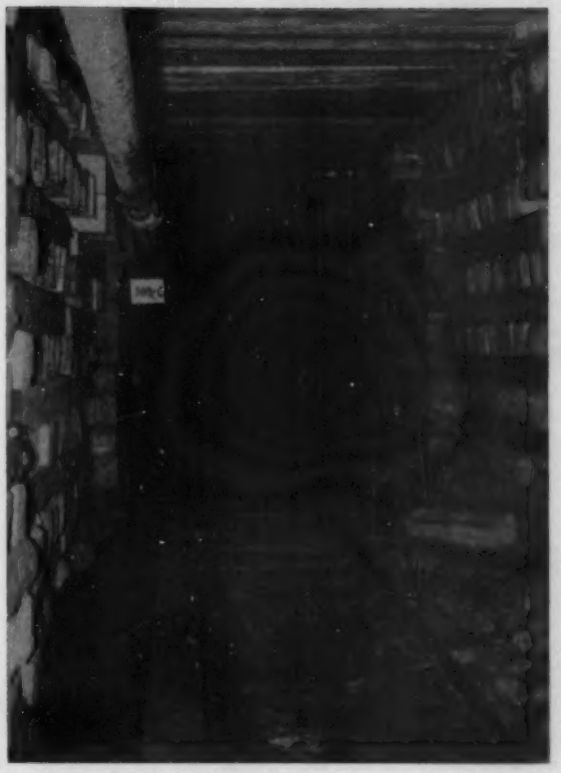
the repair period, an air hammer moil was necessary to relieve supporting members, and in some cases, the ground had to be drilled and blasted. This section was relieved many times in the first 18 months with no apparent lessening of pressure or slow-down in movement. Track has to be lowered about 18 in. every six months. This rate is unchanged today, two years after the cross-cut was driven.

The company has no way to accurately measure the rock pressure, but by a comparison of known facts such as calculated strength of the 6-in. H beam sets plus the performance and past experience with standard timber, a minimum constant pressure of about 10,000 lbs per sq ft through this one area has been determined. Conceivably, pressures in some sections are greater. Full circular sections, 10 ft in diameter, of 8-in. H beam placed on 2½-ft centers and lagged with ½-in. plate theoretically will support 14,000 lbs per sq ft. This type of support probably would have been used if costs were not almost prohibitive for the probable short life of this uranium mine.

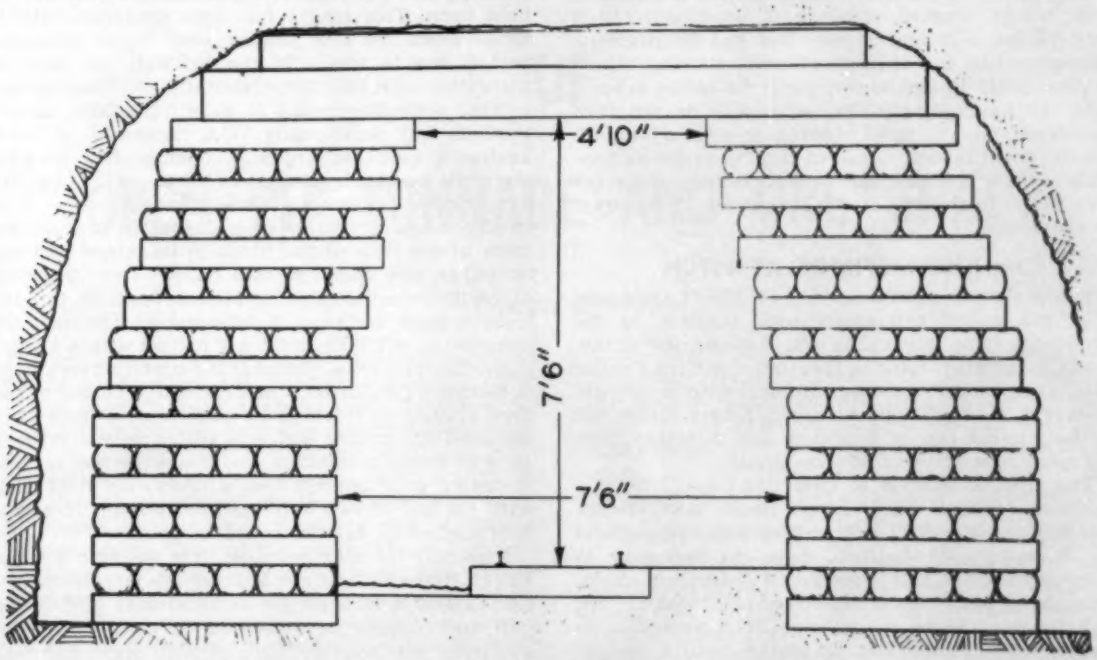
APPLICATION OF HEAVY CRIBBING

In search of a middle course, it was decided to try heavy cribbing. The cross-section of a cribbed drift is shown below. This idea is not original for it has been used at United Verde mine and is illustrated in Peale's Handbook. They used vertical walls, however, which are not satisfactory under our conditions. The first of these cribbed sets were installed in January 1960 and cribbing was raised vertically. These are still standing although side pressure has moved the bottom of the cribs inward about 6 in. This was a test section that brought out several necessary changes in method of installation and the change to the present design. Batter or arch of the cribs was increased gradually, and the last cribbing installed to date approaches this design, considered as ultimate for the company's purpose.

About 1 ft of open space is left between the crib and the rock on the sides of the drift. The back of the drift is blocked solid, with emphasis immediately above the cribs, so that maximum weight exerted downward is carried before pressure on the sides can deform the cribbed walls. The cribs actually should show evidence of weight before the walls take maximum pressure. Theoretically the standard



Timber cribs, constructed from 4-ft squared timber, used to control squeezing ground. Back is held by solid roof.



Cross-section of a cribbed drift. The standard crib section can withstand vertical pressures exceeding 11,000 lb per sq ft.

Crib section along a drift 700 ft below the surface. In place now for one year, deformation has been very minor.

cribbed section will handle more than 11,000 lbs of vertical weight per sq ft. The cribs placed to date have not exhibited any weak points and have not required maintenance. Cost of retimbering, using cribs, is approximately $125.00 per ft with timber priced at the mine portal at $50.00 per thousand bd ft.

All raising at the Pitch mine is entirely cribbed. The 6x8-in. framed cribbing is used with 10-ft wall plates, 5-ft end plates, and 6x8-in. dividers. This gives two 4x4-ft compartments. Raising, which is principally in ore, is ordinarily in better ground than the haulage way. Raises usually do not take significant weight until stoping is well advanced. Development is kept ahead of stoping as far as possible because it is necessary to complete development of a block to the top of the lens prior to the start of extraction.

MINING METHODS AT PITCH

Sublevels are driven up-dip at 100-ft intervals. They are driven principally with slushers, as the maximum raise interval is 100 ft along the strike. Track is installed later to facilitate handling timber from a central service raise equipped with an electric hoist and standard cage. All sublevels are driven flat so that timber can be moved in any direction from the main raise without adverse grades.

The stoping method to date has usually been a modified Mitchell slice. Stope floors take weight rapidly, and standard 5-ft square sets using round 7½-ft posts and 10x10-in. caps are necessary to hold the mat. The mat is composed of 4 to 7-in. diam. poles, 10-ft long. This is reinforced and chinked with slab lagging. Stope floors have been extended as much as 75 ft each way on strike from a central cribbed raise, but extensions of more than 50 ft are somewhat risky where ore width exceeds 10 ft (or 2 sets).

Ore widths throughout the mine vary from a minimum width of 3 ft to a maximum width of 45 ft. In wider ore zones, the strike length serviced by one raise must be even less than 50 ft in each direction since 50 sets per floor is the maximum that can be held open. This length has been exceeded several times when ore zone widths were larger than expected due to swells in the footwall. As may be suspected, such situations generally are troublesome.

Most orebodies found to date have been nearly vertical, but occasionally it is necessary to work against a wall that slopes as much as 50°. Because the walls are much softer than the ore, a flat-dipping hanging wall always causes some dilution. It is usually necessary to drive a slusher drift from the raise to the ends of the block to be mined and ore on either side removed in a retreat from the ends of the stope to the raise. As soon as possible, this retreat toward the raise is followed by the mat. On completion of a floor, posts are drilled with a 1¼-in. auger bit. This hole, placed at the center of each post, is loaded with one stick of dynamite, and the entire floor blasted. In starting the next floor, windows are installed by cutting out end plates in the cribbed raise as access to the floor, and the extraction process is started over again. These windows are held open with the aid of two 7-ft sections of 6-in. H beams held in place by 6x8-in. or 8x8-in. posts.

Presently the maximum depth of the adit is about 400 ft. However, sediments favorable to mineralization extend downward for an additional 1000 ft and will undoubtedly be mined in the future. Ground pressures will possibly increase with depth and may present new problems in ground support.

AT THE EAGLE MOUNTAIN MINE, KAISER STEEL CORP. PIONEERED IN . . . . . .

ELECTRONIC COMPUTATIONS OF OPEN PIT TONNAGE AND ORE GRADE

by ROBERT L. WILSON

Computation of reserve tonnages, stripping ratios, and grade of ore has long been a revolting aspect of the young mining engineer's job. Weeks at the desk calculator may turn into months before a single job is completed. Then many additional hours are necessary to check the calculations. During the last decade, computing machines have been widely publicized as instruments which will accomplish fantastic feats. Tales of their magical qualities have overshadowed their most basic characteristics—that of being a labor-saving device. Prior to a discussion of the electronic calculator's use on a mining problem, it may be well to point out that these machines are neither magic nor will they replace the judgment of an experienced engineer. In short, the "mighty morons," as the computors are sometimes called, are excellent labor savers but must be used correctly. They are not a substitute for thinking.

R. L. WILSON is Geologist of Mining and Raw Materials Division, Kaiser Steel Corp., Fontana, Calif.

PILOT PROJECT—SILVER LAKE DEPOSIT

In June 1958, data on Kaiser Steel's Silver Lake, Calif. iron deposit was being reviewed and preparations made for calculation of the reserves. The author, faced with the time-consuming reserve job, decided to investigate methods of speeding the work.

The Kaiser Steel Corp. Controllers' Division, which is responsible for the data processing equipment and programming, was contacted, and the general aspects of open pit mining, especially the reserve tonnage and average grade calculation, were discussed with R. P. Bogart, Senior Programmer. The Silver Lake problem seemed to be adaptable to the available equipment, and Bogart devised a suitable program. Pertinent information was punched on cards and processed by an IBM 604 calculator and an IBM 407 printer. In 1958, Kaiser Steel did not have a computor (an electronic calculator with memory circuits).

The data used for the Silver Lake pilot project consisted of about 3000 separate items for two orebodies, 19 geologic sections, 2350 ft of drilling, and 2345 analyses. The direct cost of the data processing was about $160, as compared to about $400 by conventional methods. Once the calculation was programmed, similar problems could be run for a direct cost of about $60. In addition to the direct cost, there were about seven hours of machine time on the pilot project. However, the IBM equipment was rented on a continuing hourly basis so no charges were made to projects such as this, where idle machine time was used. More important than the modest monetary savings was the extra 10 to 12 days which could be devoted to mining department work.

Procedure Used for Silver Lake Iron Deposit Calculation:

Required:

1) The tonnage of waste.
2) The tonnage and average grade of ore for each orebody.
3) The tonnage and average grade for the entire deposit.

Given: Geologic and topographic maps, location of drill holes, and sample analyses of seven materials. In this case, two orebodies were considered. The ore cut-off value had been established by previous experience.

Solution:

1) Evolve geological cross-sections, including drill hole and sample locations and plotting of analyses intervals.
2) Outline the ore, waste, and areas of influence on the sections for each sample analysis.
3) Place the limits of the pit on each section (previously determined in this case).
4) Planimeter waste and ore to obtain areas of influence for each hole on each section.
5) Record information from sections and analyses on data sheet (see Fig. 1).
6) Program data on computor for average grade and average end-section method of computation.
7) Insert information from data sheet into the computor. The IBM 604 uses punched cards. Verify punched data.
8) Five summation steps are computed. Fig. 2 shows sample data from punched cards as recorded on recapitulation sheets for each of the steps. Five sets of cards were prepared beginning with some 3000 in Step A (below) and decreasing to only 8 in Step E. Outlined below are the operations which are performed in each step of the computation.

Step A. (1) Ore grade for each analysis × feet of influence (for each material in each sample in each drill hole) = foot percentage product.
(2) Summation of products of A (1).
(3) Summation of footages used in A (1).

Step B. (1) A (2) ÷ A (3) = average analysis for each material for each drill hole.
(2) Area of influence for each sample × B (1) = Area — percentage product.
(3) Summation of products B (2).
(4) Summation for each section of areas of influence.
(5) Summation for each section of sample footages.
(6) Summation for each section of prior products.

Step C. (1) B (3) ÷ B (4) = average analysis for each material for each section.
(2) B (4) × width of influence of each section = volume percentage product.
(3) Summation of products obtained in C (2).
(4) Summation for each orebody of volumes of influence.
(5) Summation for each orebody of sample areas.
(6) Summation for each orebody of prior products.

Step D. (1) C (3) ÷ C (4) = average analysis for each material for each orebody.
(2) Summation of C (3) values (volume of ore and waste in total deposit).
(3) Summation of prior products.

Step E. (1) D (3) ÷ D (2) = average analysis for each material for entire deposit.

The summation of prior products is carried through the calculation for checking purposes. A printed record with data from each card and the results of all calculations is obtained from the IBM 407 printer and is referred to here as the *recapitulation sheet.*

9) Convert volumes from the machine calculation to tonnages by conventional means.

EAGLE MOUNTAIN MINE PROJECT

The obvious success of the electronic calculator in tonnage and grade calculations turned immediate attention to Kaiser Steel's Eagle Mountain mine. C. E. Davis, Chief Mine Engineer, under the direction of M. J. Hughes, Mine Manager, and R. G. Heers, Manager, Mining and Raw Materials, was preparing a plan for the new large East Pit at Eagle Mountain. Davis, who had previously considered the computor use, cooperated with R. P. Bogart in devising a program to meet the slightly different requirements of the Eagle Mountain pit calculation.

Then early in September 1959 a preliminary run to check programming and data presentation was made on data which had been previously calculated by routine methods. A defect in the original processing was found in the first run. One more digit than had been anticipated appeared in the Fe product of the second step. The machine dropped this digit, and the final result was 15 pct too low. A check of the recap sheet revealed the error which was then corrected. The preliminary run on an alternate plan included data of 22 geological sections, 24 potential benches, over 100 drill holes, and 2 ore zones.

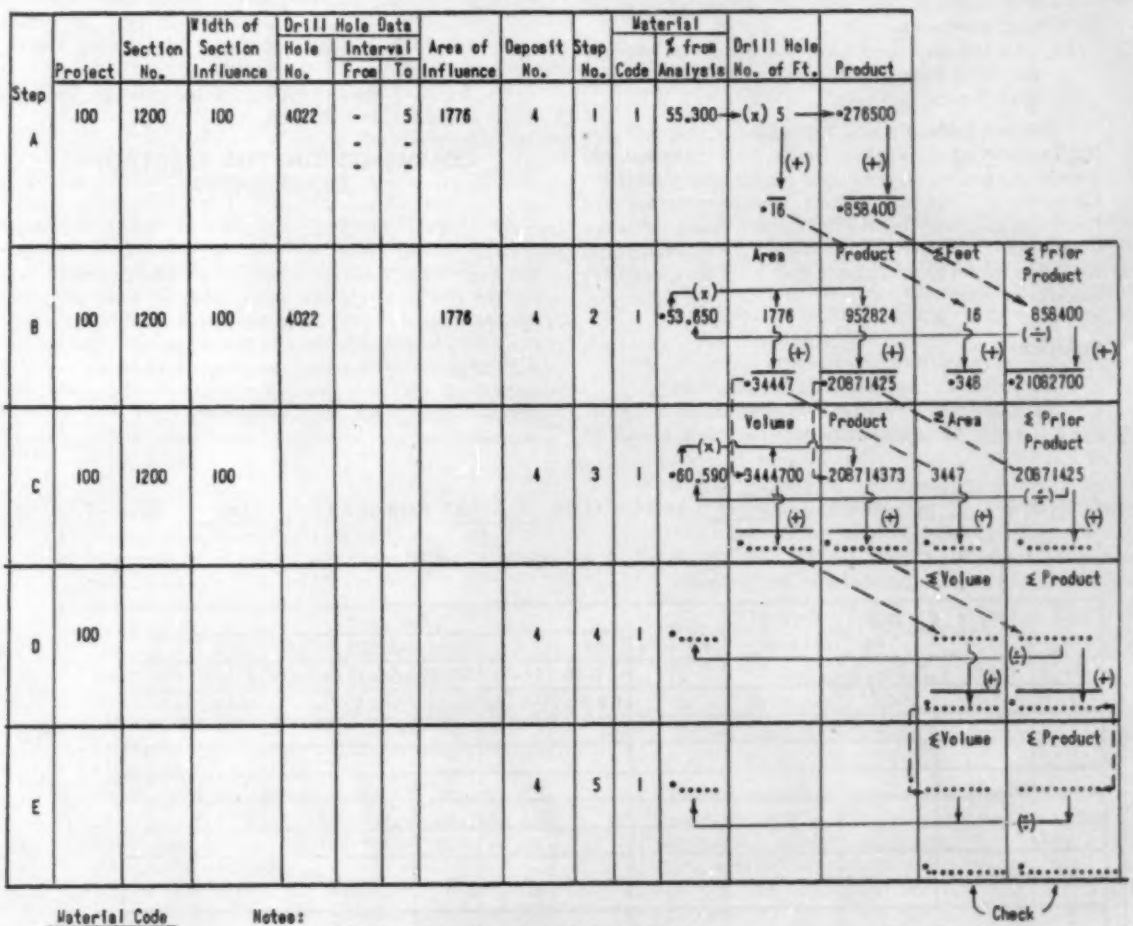
(Text continued on page 590)

Project No. 100 (1-3) Prepared by J. Doe Date 6/19/58

Section No.	Section Width	Hole No.	Interval Start	Interval Stop	Area of Influence	Ore or Waste	Deposit No.	Per Cent Fe	P	SiO2	Al2O3	CaO	MgO	S
4-7	8-11	12-15	16-19	20-23	28-32	33	34-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70
1200	0100	4022	0000	0005	01776	0	4	55,300	00492	11060	02460	01270	04540	00024

Note: Typed figures at the top of each column indicate digits assigned to various items on punch cards.

Fig. 1. Silver Lake data sheet for ore volume and average grade calculations.



Material Code	
1-Fe	5-CaO
2-P	6-MgO
3-SiO_2	7-S
4-Al_2O_3	9-Waste

Notes:
Asterisk indicates figures calculated in step.
Dashed arrow lines indicate numbers carried from one step to next.
Solid arrow lines indicate operation performed in the step; type of operation also shown.
Column headings are for explanation only and do not appear on the recapitulation sheets.

Fig. 2. Silver Lake sample recapitulation sheet.

Once the proper procedure was established, the data from the most desirable alternate plan was punched on the cards. This plan included information from 85,000 ft of core drilling, 29 geological sections, 31 proposed mining benches, 3012 combined analyses originating from over 50,000 individual analyses. The run was made without incident and the plan was eventually accepted for the movement of several hundred million tons of overburden and ore from the Eagle Mountain East Pit.

Unfortunately, no detailed cost records of the Eagle Mountain work was kept since the job was accomplished during idle machine time. It is estimated that about $2000 and three months' time for one engineer was saved. However, if the calculation had included combining the analyses and other preliminary work, C. E. Davis estimates that from $8,000 to $12,000 would have been saved as well as a year's part time work of three engineers.

Procedure Used for Eagle Mountain Mine Calculations

Required:

1) The tonnage and average grade of ore for each proposed mining bench.
2) The tonnage and average grade of ore for each ore body.
3) The tonnage and average grade of ore for the total deposit which is within the mining plan limits.

Given: Geologic and topographic maps showing location of drill holes, drifts, and other sample points; a total of 39 proposed mining benches with elevations. Two ore bodies are considered. Pit limits had already been established. Analyses were averaged for each drill hole by conventional methods several months prior to the electronic calculator use.

Solution:

1-3) Same as the Silver Lake solution.
4) Planimeter waste and ore areas of influence for each drill hole on each bench of each section. Due to geologic features, the distance of influence of each sample on each side of the section is also determined at this time. At Eagle Mountain, sulfur was handled in a special manner due to its gradual increase with depth. In this step, considerable judgment and experience is required for those decisions which cannot be made by the data processing machines.
5) Record information from sections and analyses on data sheet (see Fig. 3, Eagle Mountain Sample Data Sheet.)
6) Program data for electronic calculator using average end-section and volume weight method of calculation.
7) Insert information from data sheet into the electronic calculator. Punched cards are used in the IBM 604 machine. Verify punched data.
8) Computation is made in five steps as shown on Figure 4, "Eagle Mountain Final East Pit Recap Sheet." In general the procedure was to sum up the drill hole data; then combine the drill hole data into benches; followed by bench data into ore zones; and finally ore zones into totals for the deposit. Summations can be made both by ore zone and by mining bench, and used for a check.
9) Convert ore volumes to tonnage by conventional means.

COMMENTS ON THE ELECTRONIC CALCULATOR

An important use of the electric calculator is on repetitive problems with many individual calculations. Many ore reserve computations are essentially a "one shot" operation and, thus, to gain any advantage must have a considerable number of calculations—probably on the order of 2500 minimum.

Electronic calculating equipment is being rapidly improved. With a machine such as the IBM 604 much work went into preparing the five sets of punched cards. Improved machines with memory

Project No. 99-6 (1-3) Section No. 0011 (4-7) Section Width 0200 (8-11) Prepared by J. Doe Date 7/23/58

Hole No.	Sample No.	Skip to	Bench No.	Area of Influence	Ore Zone	Per Cent Fe	P	SiO_2	Al_2O_3	CaO	MgO	S
12-15	16-19		24-27	28-32 In^2	35	36-40	41-45	46-50	51-55	56-60	61-65	66-70
0328	0001		0011	00006	2	49.600	00.036	008.40	001.80	002.50	004.30	00.030

Note: Typed figures indicate digits assigned to various items on punched cards.

Fig. 3. Eagle Mountain data sheet for iron ore grade calculations.

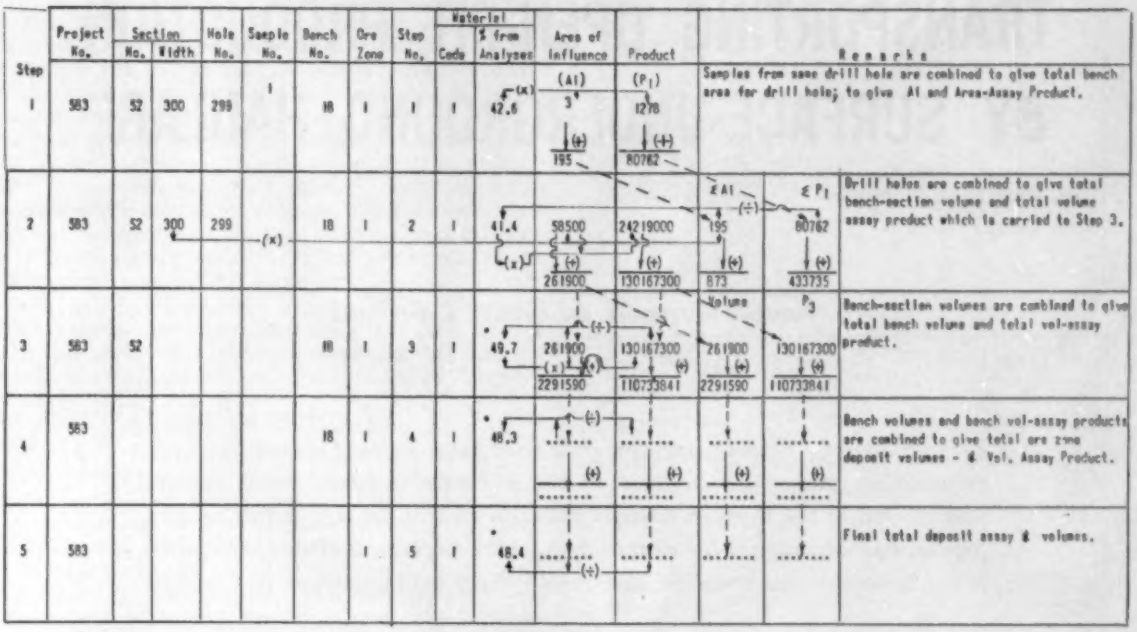

Step
Project No.
Section No.
Section Width
Hole No.
Sample No.
Bench No.
Ore Zone
Step No.
Material Code
% from Analyses
Area of Influence
Product
Remarks
Samples from same drill hole are combined to give total bench area for drill hole; to give Al and Area-Assay Product.
Drill holes are combined to give total bench-section volume and total volume assay product which is carried to Step 3.
Bench-section volumes are combined to give total bench volume and total vol-assay product.
Bench volumes and bench vol-assay products are combined to give total ore zone deposit volumes - & Vol. Assay Product.
Final total deposit assay & volumes.
Material Code
1-Fe 4-Al2O3
2-P 5-CaO
3-SiO2 6-MgO
7-S
Explanation:
--- Numbers carried from one step to next.
Operations performed within step. Arrow points to result. Type of operation indicated.
• Assays are rounded to nearest 0.1.

Fig. 4. Eagle Mountain in final East Pit recapitulation sheet.

circuits need only one step to do the same calculations. Unfortunately, the more complicated machines require more time to program. Care must be taken by the programmer to see that calculations are fitted to the capacity of the machine. If insufficient digits are assigned to large products, significant figures may be dropped by the machine, and an inaccurate result may be obtained.

The following are some of the advantages and disadvantages noted during Kaiser Steel Corp.'s use of the data processing equipment on the mining problem:

Advantages:

1) Rapid completion of calculations.
2) Immediate check of all steps of the various calculations.
3) Considerable saving of money on large programs.
4) Minimum effort on part of the usually undermanned mining department.
5) If data processing equipment is available within the company, the program can generally be run between the regularly scheduled jobs.
6) Basic data can be analyzed in several different ways; i.e., individual parts of pits or a combination of pit areas may be examined as desired.
7) Variations of calculations, too time-consuming to be ordinarily considered, can easily be run after the data is entered on the keypunch cards.
8) Periodic checks of ore tonnage and grade, both removed and remaining during the entire life of the pit, can be made largely from the data of the original calculation.

Disadvantages:

1) Chance for major error in calculations from:
   a) attempts to use machine for thinking (the machine is not a substitute for judgment).
   b) misunderstanding of problem by programmer who generally is not trained in mining subjects.
2) Possible misunderstanding by management of machine capabilities.
3) No monetary saving will be realized if program is not suited to the machine; i.e., short calculations.
4) Punched cards or other machine data may be lost before needed again. It is well to store the cards in the mining department.
5) Electronic calculating equipment becomes obsolescent rapidly and may be changed often if obtained on lease; thus additional runs may require costly reprogramming.

CONCLUSIONS

The following conclusions were reached as a result of Kaiser Steel's use of the electronic calculator on open pit reserve calculations:

1) The tonnage and grade computation can be run efficiently and quickly on calculators.
2) Significant savings of money and mining department personnel time can be realized.
3) All persons concerned should understand the problem as well as the machine's limitations.
4) Input data, such as punched cards, can be used over a period of years for variations of the basic problem if the data is preserved and if the same machines are available.

With this in mind, modern mining can also employ modern electronics.

TRANSPORTING OPEN-PIT PRODUCTION BY SURFACE-UNDERGROUND HAULAGE

by

EUGENE P. PFLEIDER and CYRILLE A. DUFRESNE

The problem of moving open-pit ores over large vertical distances is increasing in importance because of the immense deposits being mined. Gravity fall of ore through transfer raises to central haulage points underground has advantages for certain open-pit operations, and this method is being seriously considered for the Carol Project now underway in Canada.

Open pit mining methods produce more than 80 pct of all raw materials today in the United States. Much of this comes from properties that formerly employed underground methods, and were converted to open pit; or from mines that ultimately must go underground when the economic strip limit is reached. Generally the ores are transported over large vertical distances, and ingenious techniques have been developed to do this economically. One approach is to combine conventional surface trucking, over relatively level roads, with the use of gravity and underground facilities. There are various modifications, depending upon the character of the orebody and the topography. Several schemes, as used in Sweden, Canada, and the United States, merit describing.

One of the critical problems involved in the transference of ores from surface to underground is that of *flow of bulk solids*. Must it be crushed? Will it hang up in the transfer? What size and inclination of ore pass are required? How is the ore best fed onto the transporting device underground? These are but a few of the questions that plague the designer of such systems. The planning engineers for the new Carol Project of the Iron Ore Company of Canada faced these problems in making their preliminary designs for the eventual production and transportation of some 55,000 tpd from their Carol and Lorraine orebodies in Labrador. Other operations, using somewhat similar methods, were contacted for design data and counsel. This article presents the results of that study.

ALTERNATE TRANSPORTATION SYSTEMS

The type, shape, dip, and size of the orebody, as well as the surface topographic features, generally establish the method of transporting and hoisting the open pit ore after it is dropped down the ore transfer to underground facilities. The various systems may be classified as follows:

A. Underground Transport Method
- 1) Conveyor —Spruce, Susquehanna, Algoma, Caland,
- 2) Railroad Adit —Kiruna, United Verde, Sullivan; Carol Project (under consideration).
- 3) Shaft —Susquehanna, Caland.

B. Crushing
- 1) Surface —Spruce, Susquehanna, Kiruna.
- 2) Underground —Algoma.
- 3) None —Caland, United Verde, Sullivan, Carol Project (under consideration).

C. Ore Passes
- 1) Vertical —Spruce, Susquehanna, Algoma, Kiruna; Carol Project (under consideration).
- 2) Inclined —Caland, Sullivan, United Verde
- 3) With knuckle at bottom —Algoma, Sullivan,
- 4) With bulldozing chamber and storage bins —United Verde.
- 5) With inspection raises & drifts —Sullivan, United Verde.

Interestingly, all four of the mines employing an underground conveyor are iron ore producers. The Spruce[1] and Susquehanna properties are on the Mesabi Range in Minnesota, whereas the Algoma and Caland operations are in Ontario. The former is in the Michicipoten area, whereas the latter is a new $60 million development in the Steep Rock district. The ore at Caland breaks sufficiently fine in the open pit to permit its being loaded directly onto the belt conveyor by an apron feeder. The other three mines require crushing ahead of the belt.

The Kiruna open pit mine and the proposed Carol Project are designed for railroad cars operating in

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adits, as was also true at the former Sullivan open pit mine. The management at Kiruna found it advantageous to crush their direct shipping, high-grade iron ore in the open pit which permitted fast loading of the ore cars carrying the product to Narvik, the shipping port. It has been proposed at the Carol Project to transport the low-grade concentrating ore at original pit size to a central crusher located at the concentrator site. United Verde Copper[3,4] in the Jerome district of Arizona did not crush the ore, but did employ a blasting chamber and grizzly in their ore pass in order to control the size of feed loaded into their smaller mine cars.

Two of the operations employ shaft hoisting, either because underground mining was used originally (as at the Susquehanna mine), or because it is to be used for the deeper extensions, as at Caland.

DESIGN OF ORE PASS

The most difficult engineering design problems in the underground handling of ores are those associated with ore passes and car loading. Should the transfer be vertical or inclined? Is a knuckle desirable just ahead of the loading chute in order to break the velocity of fall? What are the optimum dimensions of this transfer? The decision involves a knowledge of bulk solids flow, particularly for the specific ore to be handled. This is a subject on which there are little engineering data. Designs are made on the basis of past experience, prejudices, and a small amount of model flow studies. The problem is important to a mining engineer, and much research is needed. More trouble is experienced in the flow of ores in raises, chutes, and from stock-piles and cars, than in any other facet of mining. Of the seven properties described above, four used vertical ore passes and three have inclined passes; two employ "knuckles" ahead of the chute gates.

The important factors that must be taken into consideration for the design of ore passes include:

1) The size distribution and size segregation of the particles in the ore mass.

2) The shear strength (s) of the ore mass, with

$$s = c + p \tan \phi$$

where c is the cohesive strength, p represents the compressive loading on the material, and tan ϕ is the coefficient of internal friction.

3) The height of fall in the ore pass, as related to the tendency of the ore to crush and to pack.

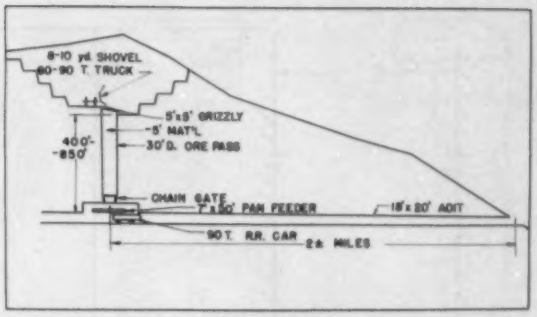
4) The characteristics of the wall rock of the ore pass —its resistance to slabbing and abrasive wear, with a resultant friction factor (μ) between sliding ore mass and the wall.

5) The flow rate and storage capacity desired.

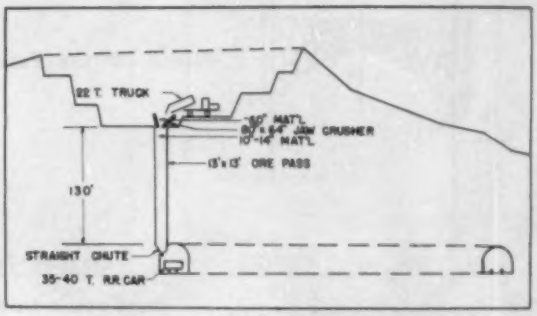
6) The climatic conditions, (i.e., snow, freezing temperatures, rain, etc.).

The mechanics of ore flow in vertical and inclined transfer systems are compared in Fig. 1. Here, the normal pressures (n) developed against the walls are shown to be a complex function of the unit weight (γ) of the ore, its cohesive strength (c) and coefficient of internal friction (ϕ), the height of ore column (H) and the diameter of the pass (D). Similarly, the resisting forces (r) are a function of the normal pressures and the friction factor (μ). The forces causing downward sliding (w) are, of course, directly related to the weight of the mass (v, H, D). L = inclined length for inclined ore pass (equivalent to H for vertical pass).

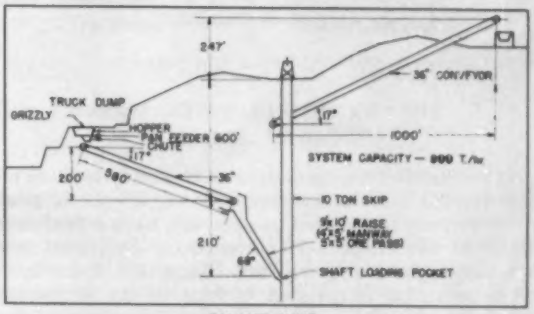
Arching characteristics are of equal or greater importance than the side wall resistances. The forces



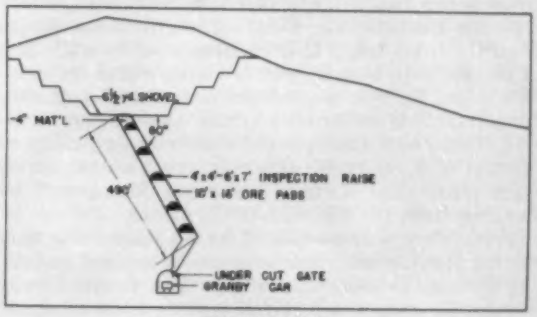
CAROL PROJECT



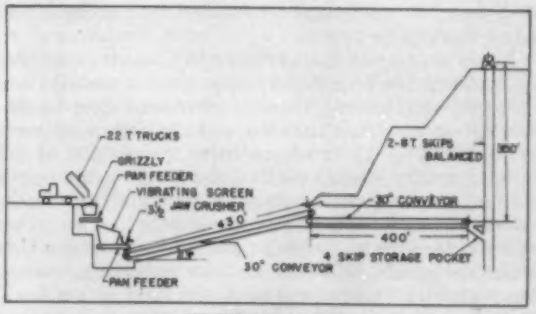
KIRUNA MINE



CALAND MINE



SULLIVAN MINE



SUSQUEHANNA MINE

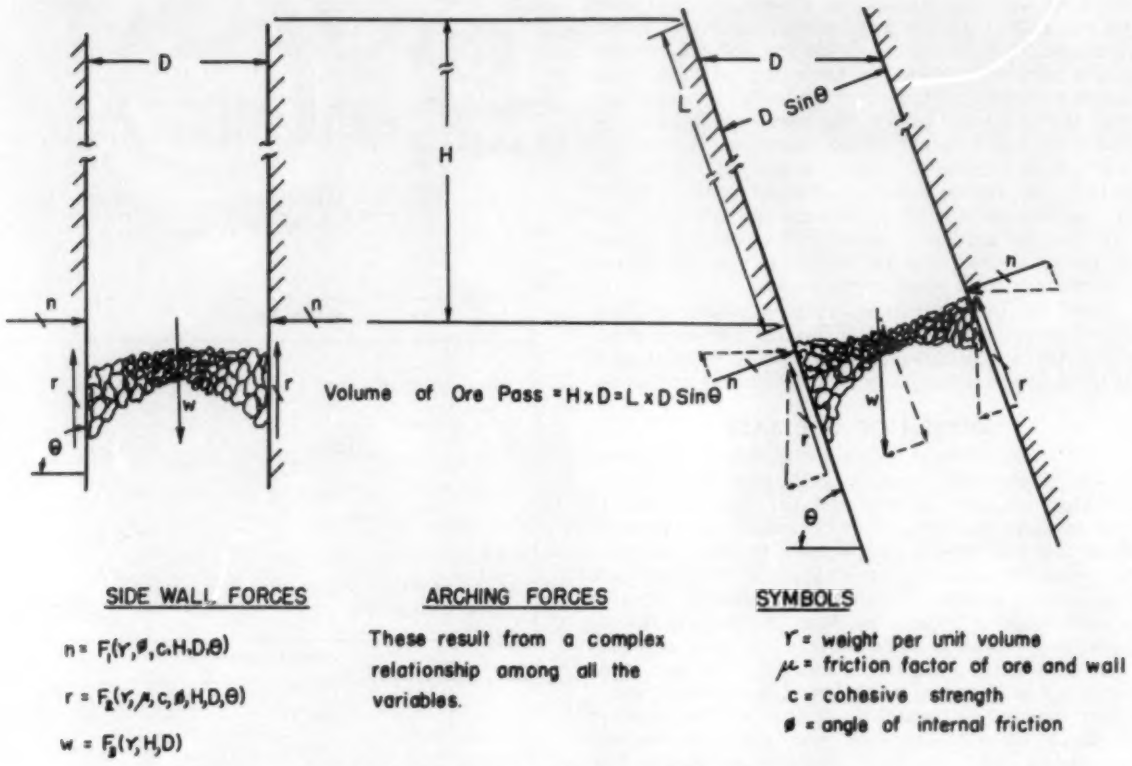


Fig. 1—The Mechanics of Rock Flow in Ore Transfer Systems.

and strengths developed in an arch are a result of all the various factors. The tendency of an ore to pack or to become segregated in sizes, can have a profound effect in this respect. Experience has indicated that ore passes generally will not "hang up" if the least cross-sectional dimension is four to six times the diameter of the largest ore pieces. However, if the broken ore has a large percentage of fines, which develop considerable shear strength when moist, then the mass tends to arch from wall to wall. This is particularly true in cold climates where ice crystals might form in a quiescent ore mass during prolonged periods of shutdown, such as over the weekend. Generally calcium chloride was employed at Kiruna and Sullivan, either to avoid or to correct such situations. Kiruna has freed "hang-up" by flooding from the top with $CaCl_2$ brines.

Friable ore will break and form considerable fines during loading and dumping operations and in falling through considerable heights. The kinetic energy developed in such a free fall will do a considerable amount of primary and secondary crushing. This is, of course, an advantage—provided that arching and hang-ups can be avoided.

Many engineers, particularly in Canada, feel that an inclined ore pass flows better than a vertical one of equal dimensions. Their contention might be defended on the basis that the unbalanced component of forces (Fig. 1) resulting from the weight of the flowing media keeps breaking the arch on the upper side of the ore pass, whereas the symmetrical forces developed in a vertical transfer result in a situation more favorable to arching—particularly where side walls are rough. However, by like reasoning, the ore has a greater tendency to pack and hold on the footwall side of the incline. It is important to note that similar horizontal dimension, D, for both the vertical and inclined passes gives equal volumes of excavation in both cases. However, the normal cross sectional dimension for the incline is only $D \sin \theta$.

Occasionally there is reason to have the inclination of the ore pass somewhat normal to the dip of the formations in order to diminish the wear and the slabbing of the walls. It is understood that the management of Consolidated Mining and Smelting Co.[8] had this in mind when driving their inclined ore pass at Sullivan. A rough, or a stepped wall could have a pronounced effect on arching. Good design must take these geologic conditions into consideration.

To study this problem the Iron Ore Company of Canada retained the services of a materials handling consultant. He made shear tests of the fine ore, which at a certain moisture content will hold at slopes of 70° in a bin. The study confirmed the possibility of channeling through normal types of ore passes, and it indicated the effectiveness of constriction at the throat as well as a split of flow into two unloading chutes. Perhaps another minor advantage of such design is that it gives a slight turn-back near the bottom, which is a good protection to the chute according to those having experience with "knuckles" in their ore passes.

Some authorities feel that an inspection raise alongside the ore pass is advisable in order to check flow, break hang-ups, etc. However, the present trend of thinking is to so design the pass that this precaution will be unnecessary.

CAR LOADING LAYOUT

Assuming good consistent flow of ore to the chute gates, the major problem then becomes one of con-

trolling the rate of loading onto the next system of transportation—whether it be into cars, into crushers, or onto conveyors. Again, there are proponents of:

1) Direct gravity flow, employing heavy chain feed controls and undercut gates.
2) Side-loading pan feeders.
3) Over-the-car pan feeders.

The first method requires less capital investment, and it is probably fastest and best for small size ore. For uncrushed run-of-mine ore, however, there is always fear of overloading or uneven loading. This can cause serious difficulties for fast moving trains operating in confined tunnels; for example, if a 5-ft diam rock topples from the side of a car.

It is for this reason that the engineers at the Carol Project have tended to prefer the "over-the-car" pan feeders, as illustrated in Fig. 2. The objective would be to load 90-ton cars at an average rate of approximately 2000 long tons per hour. The movement of the train would be controlled remotely by the loading operator. A traveling inverted-V pan could be spotted over the space between cars in order to avoid dribble onto the tracks. Most of the fines adhering to the flights of the pan feeder would fall directly into the cars below. The small amount dropping when there is not a train spotted could be easily collected in a trough between the tracks. Positive control of the pan feeder should eliminate top-heavy loading of the cars. Maintenance of the pan feeder should be simple because of easy access to it by special equipment mounted on flat cars.

One critical problem revolves around the damage to car bottoms and axles from the 6 to 8 ft drop of large boulders that may weigh as much as ten tons. Shock absorbers, possibly massive pieces of rubber, mounted under the track at loading site can minimize the impact.

Comparison of Ore Transportation Methods at the Carol Project, Labrador

	Truck-Ore Pass-Tunnel	Truck-Ramp-Surface RR	Direct into Surface RR
Capital Requirements[1]			
Railroad Trackage:			
Main Line (miles)	6.6	10.1	10.1
Yard and Benches (miles)		11.2	16.6
Tunnel (miles)	3.8		
Rolling Stock:			
Locomotives	4 (60 tons each)	7 (125 tons each)	10 (125 tons each)
Cars (90 short ton capacity)	95	220	220
Trucks:			
40-ton Rear Dump		10	[2]
60-ton Trailer Type	11		
Ore Transfer Raises	4		
Personnel Required for Ore Transportation Only	94	120	98
Cost Estimates[3]			
Initial Capital Costs (millions of dollars)	15.1	15.7	17.4
Relative Unit Costs:[4]			
Capital Write-off Including Interest (pct)	35	37	37
Operating Labor			
Operating Labor (pct)	15	20	16
Operating Supplies and Maintenance Charges (pct)	50	64	52
Total *Relative* Unit Costs (pct)	100	121	105

[1] Capital requirements are based on estimated production rate of 13,400 tons per shift.
[2] 40-ton rear dump trucks used only in opening-up benches.
[3] Cost estimates are based on an initial annual capacity of 5.5 million long tons of concentrates.
[4] For comparative purposes, unit costs of the three systems are given as percentages adjusted to a base represented by the "Truck-Ore Pass-Tunnel" system.

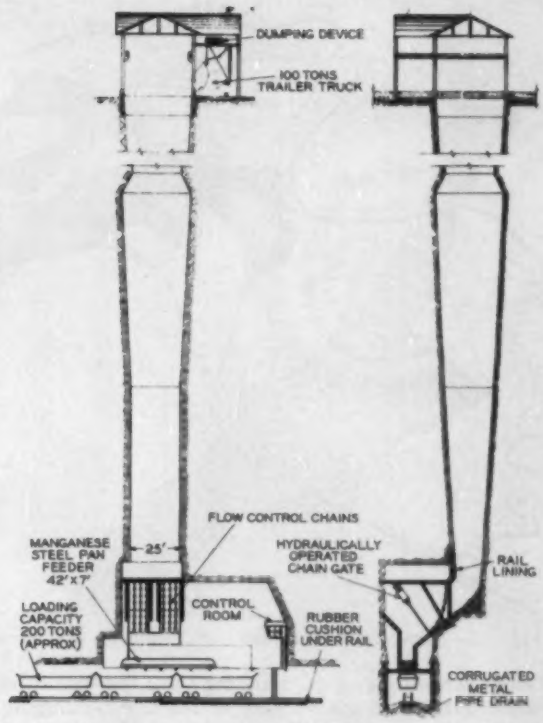


Fig. 2—Preliminary ore pass layout proposed at Carol.

TENTATIVE DESIGN OF THE CAROL PROJECT

The new Carol Project has the geologic and topographic conditions that favor the consideration of a truck-ore, pass-adit system. This property, now under construction in Labrador, 225 miles north of Seven Islands on the Gulf of St. Lawrence, is designed to produce seven million tons of 66 pct Fe concentrates annually from 16 million tons of crude ore. It will require the mining and transporting of 18,000 tons per 8-hour shift. Initially the ore will come from the nearby Smallwood mine which, located at a lower elevation and favored with more gentle slopes, can be mined by standard open-pit methods. Within a few years, however, the adjoining Carol and Lorraine orebodies will provide feed to the plant. These orebodies are much more difficult of access, and serious consideration is being given to the truck-ore, pass-adit system of transport.

A profile along a possible tunnel line and a cross section through the orebodies (Figs. 3 and 4) depict the general geologic and topographic features, together with ore pass locations. The truck-ore, pass-adit system would require 6.6 miles of surface railroad from mill site to tunnel, 3.8 miles of 18x20-ft tunnel, and four 30-ft diam. ore passes totaling 2600 ft in length (see table opposite).

The design for proper benching and level hauling offers many interesting combinations. One approach, presented in Fig. 5, provides for carrying benches 30 to 50 ft high, depending on size of drilling and excavating equipment. The truck-loading station would be lowered upon the completion of either one, two, or three benches, as dictated by economics. All hauling would be on level ground, employing side-dump trailer trucks of 60 to 90-ton capacity, except for short ramps leading from the bench immediately above or below the dumping station.

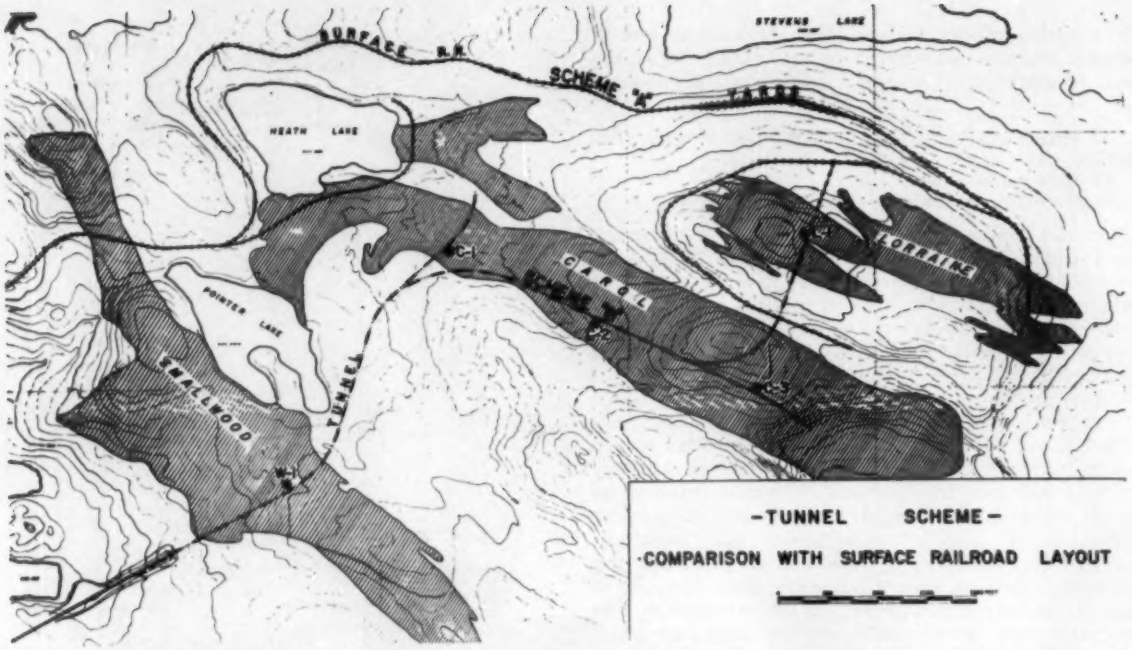


Fig. 3—Comparative studies of tunnel vs. surface rail haulage favor the former system at carol.

Good scheduling and planning will be required when blasting in the vicinity of the truck-dumping station, or when lowering it. By placing the ore transfers at 2750-ft centers, average round-trip truck hauls can be restricted to an estimated length of one mile.

Alternates to this ore transfer approach include 1) direct loading into railroad cars; 2) loading into trucks and transporting to car loading pockets or ramps; and 3) block caving.

A surface railroad system designed to service both the Carol and Lorraine orebodies would require 10 miles of main line track, a mine switching yard to handle 120 cars, and some 14 miles of mine track. Moreover, use of a railroad in this open-pit operation is aggravated by the fact that both summer benches and protected winter benches are considered necessary because of severe climatic conditions. The method lacks flexibility, and in any event, the original opening-up of benches would have to be accomplished with the use of truck transportation to railroad car-loading pockets because of the steep slopes.

The method of loading ore into trucks and transporting it to car loading pockets received much study. In fact, it is the procedure that will be followed for the mining of the Smallwood orebody. This system affords flexibility, but for the Carol and Lorraine orebodies, cost estimates indicated that it would be somewhat more expensive than an ore pass system in cases where elevation differences from ore benches to the tunnel line are of the order of 500 to 900 ft.

As for block caving, it has several disadvantages when compared against open pit mining with low strip ratios. First, contamination of ore with waste is greater; secondly, costs are invariably higher as proven at many operating properties that converted from underground block caving to surface mining.

COMPARISON OF TRANSPORTATION METHODS AT THE CAROL OREBODY

Rather extensive studies were made of the capital requirements and the cost comparisons for the various methods of transporting ore from the working face at the Carol—Lorraine orebodies to the concentrator site alongside Wabush Lake. Leading tunnel contractors furnished tentative cost estimates on the long adit. Expert counsel was received from outstanding mining personnel in Canada, Sweden, and the United States. The salient factors are presented in the accompanying table.

It was somewhat surprising to learn that the estimated capital cost for the long adit-transfer system was less than that for the two alternate methods. The reason for this lies in the fact that the surface railroad route traverses a rugged, rocky country,

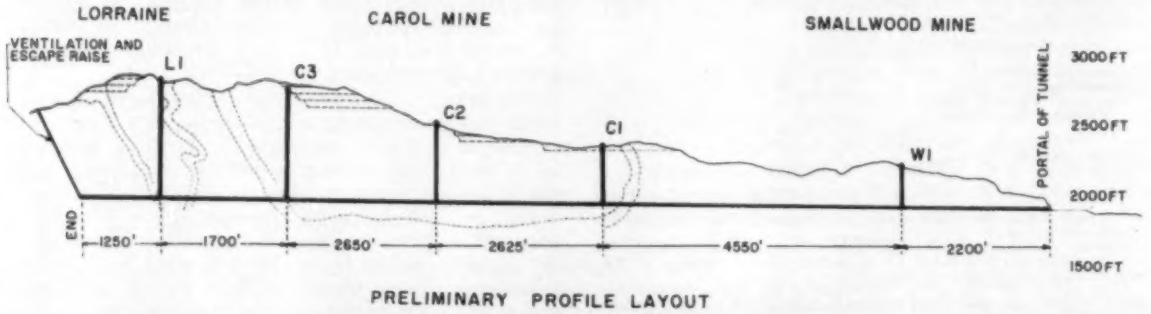


Fig. 4—The proposed tunnel for ore haulage from the Carol and Lorraine iron ore deposit.

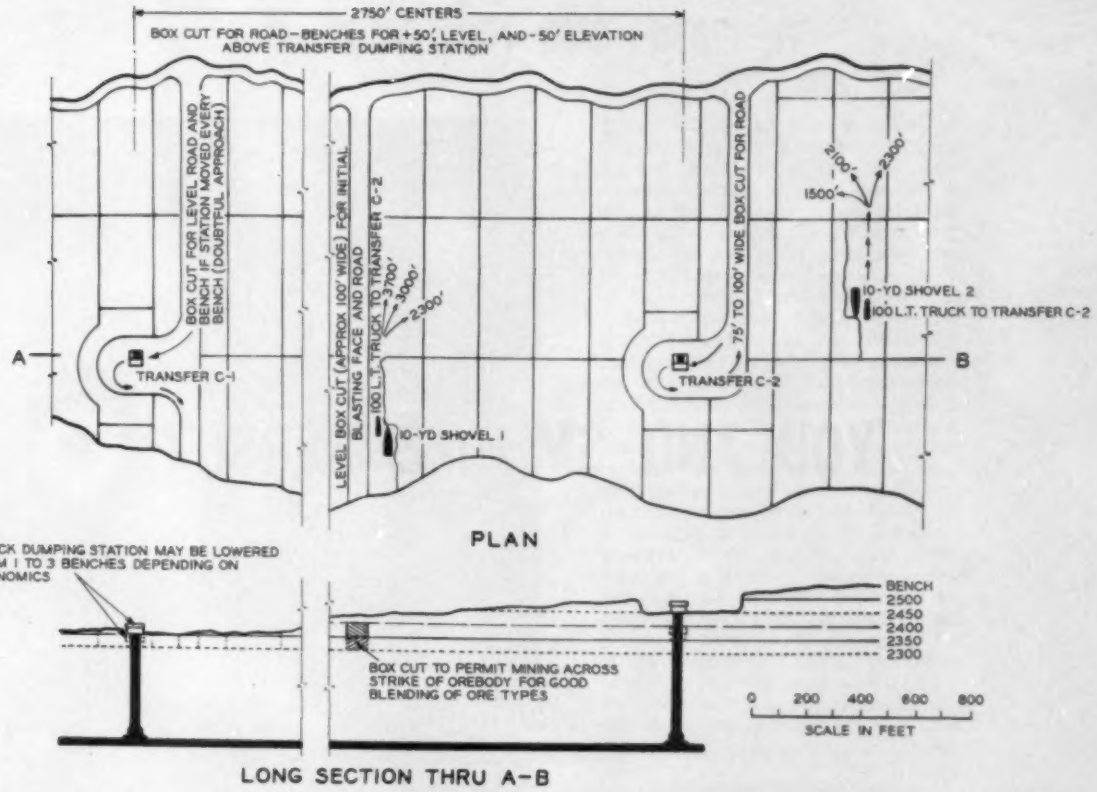

2750' CENTERS
BOX CUT FOR ROAD – BENCHES FOR +50', LEVEL, AND -50' ELEVATION ABOVE TRANSFER DUMPING STATION
BOX CUT FOR LEVEL ROAD AND BENCH IF STATION MOVED EVERY BENCH (DOUBTFUL APPROACH)
LEVEL BOX CUT (APPROX 100' WIDE) FOR INITIAL BLASTING FACE AND ROAD
100 L.T. TRUCK TO TRANSFER C-2
3700'
3000'
2300'
75' TO 100' WIDE BOX CUT FOR ROAD
2100'
2300'
1500'
10-YD SHOVEL 2
100 L.T. TRUCK TO TRANSFER C-2
A
B
TRANSFER C-1
TRANSFER C-2
10-YD SHOVEL 1
PLAN
TRUCK DUMPING STATION MAY BE LOWERED FROM 1 TO 3 BENCHES DEPENDING ON ECONOMICS
BENCH
2500
2450
2400
2350
2300
BOX CUT TO PERMIT MINING ACROSS STRIKE OF OREBODY FOR GOOD BLENDING OF ORE TYPES
0 200 400 600 800
SCALE IN FEET
LONG SECTION THRU A-B

Fig. 5—A truck haulage system proposed for the Carol open pit. Blasting blocks shown on plan are 500 x 200 ft.

resulting in high costs. As expected, the operating costs and personnel requirements were considerably less than the truck-to-ramp-to-railroad car approach and were approximatey the same as that for direct loading into railroad cars. In this respect, it must be remembered that full direct-loading could not be used during the initial five-year period, during which time benches are being opened on the steep hill slopes.

In the table on page 595, unit costs are presented as percentages, using 100 pct for the "truck-ore pass-tunnel" system as the base. Capital write-off charges of 35 to 37 pct of the total unit costs are about normal for this type of open-pit operation. The 15 to 17 pct figure indicated for operating labor *does not include* maintenance or supervisory personnel. Their cost was included in the maintenance item because of the method employed in estimating. Full labor charges are thought to represent also about one-third of total unit costs.

CONCLUSIONS

The use of ore passes and underground facilities to transport surface-mined ores has been applied successfully in various places throughout the world. Looking to the future, it is expected that many additional mining companies will consider its application to orebodies extending from the surface to appreciable depths. Invariably in the study of such methods, there arises the question of the flow of ore in the passes and its proper discharge from ore chute to cars or conveyors.

Again, as in most mining operations, we are faced with the important problem of flow of bulk solids or of fragmented materials. This area of engineering always has received much thought by designers faced with a specific situation. Unfortunately, there has been inadequate basic research in defining the principal parameters. We hear constantly of chutes that won't feed or bins that hang-up. The soils engineer has already developed excellent concepts that can be translated to our purpose. Some pioneers in the field of solids flow, such as Dr. Andrew Jenike[6,7] at the Engineering Experiment Station of the University of Utah, have made outstanding contributions, but their work must be amplified and supplemented. New principles, as developed, must be taught to mineral engineers and to men in the materials handling field. Perhaps then we can design ore transfers and loading stations with greater conviction as to size, inclination, shape, and form of withdrawal.

It is hoped that this paper will stimulate free discussion on the subject from mining authorities throughout the world. With such impetus, better design of ore pass systems should evolve.

The authors wish to extend their thanks to the management of the companies cited for giving us the opportunity of presenting the information relative to their particular operations and studies.

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[4] United Verde Operations. *Min. Cong. J.*, April 1930, pp. 331, 336, 338-342.
[5] The Operations and Plants of the Consolidated Mining and Smelting Co. Ltd. *Canadian Min. J.*, May 1954, p. 160.
[6] A. W. Jenike: Flow of Solids in Bulk Handling Systems. AIME Minerals Beneficiation Division Meeting, September 1954.
[7] A. W. Jenike: Flow of Bulk Solids in Bins. Bulletin, Univ. of Utah, Vol. 45, No. 9 (Part II), March 1954.

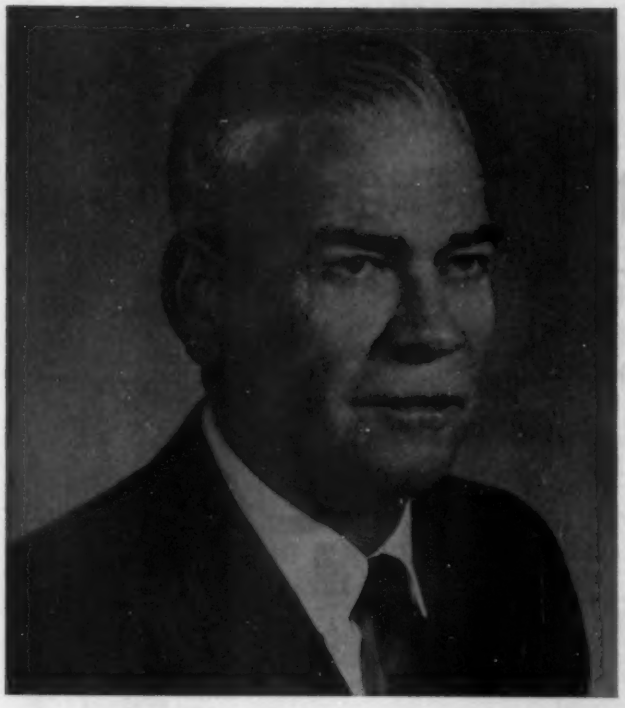
YOU AND SME MEMBERSHIP

Starting on the facing page is a 16-page section giving a picture of SME and its component parts—and what they mean to a prospective member.

The section is being included in this issue of MINING ENGINEERING, *we again realized that almost all of the material would be of interest to members who, far too seldom, are given an overall picture of the Society to which they belong. A once-a-year refresher is good for all of us who belong to—and believe in—SME.*

Again, as in 1959 and 1960, this section will be reprinted and available for use as part of SME's membership campaign. We know the membership campaign has your moral support—but if SME is to grow stronger, we need the efforts of every member on a man-to-man basis. Your Society's continued strength—and future— is your individual responsibility.

J. C. GRAY, 1961 SME PRESIDENT



James C. Gray was installed as President of the Society of Mining Engineers for 1961 at the AIME 90th Annual Meeting in St. Louis. He is administrative vice president, raw materials, for U.S. Steel Corp., with which he has been associated for nearly 25 years. Mr. Gray is a native of Pennsylvania and a graduate of Pennsylvania State University. After graduation, he went to work for Hudson Coal Co. where he remained for 12 years. In 1937 he became associated with the Tennessee Coal & Iron Div. of U.S. Steel at Fairfield, Ala., as superintendent of the Wylam mine. Progressing through various management positions in coal and iron ore mining and manufacturing, he became manager of the division's manufacturing operations in 1950. Four years later he was named vice president of the coal division. Mr. Gray has been active in professional and civic associations, including the AIME Executive Committee, acting as chairman of the Southeast Section. He also was a member of the American Iron and Steel Inst.; the Coal Mining Inst. of America; and the Advisory Council of the Coal Division of the American Mining Congress.

WHAT IS SME?

The Society of Mining Engineers (SME) is a constituent Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). The Mining Engineers are the oldest professional group and, until recently, have been the largest of the three Societies of AIME (the others are The Metallurgical Society and the Society of Petroleum Engineers).

As the result of a meeting in Wilkes-Barre, Pa., in April 1871, the American Institute of Mining Engineers, as it was then called, was founded. Objectives of this first meeting were, "First, the more economical production of the useful minerals and metals. Second, the greater safety and welfare of those employed in these industries."

Today the purpose of AIME remains much the same: "To promote the arts and sciences connected with the economic production of the useful minerals and metals, and the welfare of those employed in these industries by all lawful means; to hold meetings for social intercourse and the reading and discussion of professional papers, and to circulate by means of publications among its members the information thus obtained, and to establish and maintain a place for meeting of its members, and a hall for the reading of papers and delivery of addresses, and a library of books relating to subjects cognate to the sciences and arts of mining and metallurgy."

That original meeting in April 1871 was attended by a group of 21 men. When formal membership rolls were published, 71 names were listed. From that preliminary membership list, the Institute, in 90 years, has grown in size to over 35,000 members, including students.

Although both "mining" and "metallurgy" were terms used in the organizational call and other announcements, the word "metallurgical" was not included in the Institute name until 1919. In 1956 the word "petroleum" was added, giving full titular recognition to the three full-fledged branches of the minerals industry—Mining, Metallurgy, and Petroleum.

Perhaps the most concrete testament to AIME achievements is the *Transactions*—volumes of technical literature published. No. 1 is dated 1871. Of particular interest to miners is No. 217, publication date: 1960.

Prior to 1956 three groups within AIME were Branches of the Institute under the direction of the Board of Directors of AIME. In 1956 when the three Branches became constituent Societies of AIME, each was organized with its own President and Board of Directors. Decisions which relate to all three remain in the hands of the AIME Board. The Society of Mining Engineers prior to 1956 was known as the Mining Branch of AIME. Under the reorganization plan of the Institute, the Society came into being at New Orleans in February 1957. Today over 13,000 names are listed on the membership rolls of the Society. To learn more about SME, the men who run it, how it operates, and what it offers its members, we invite you to read the following pages.

SOCIETY OF MINING ENGINEERS

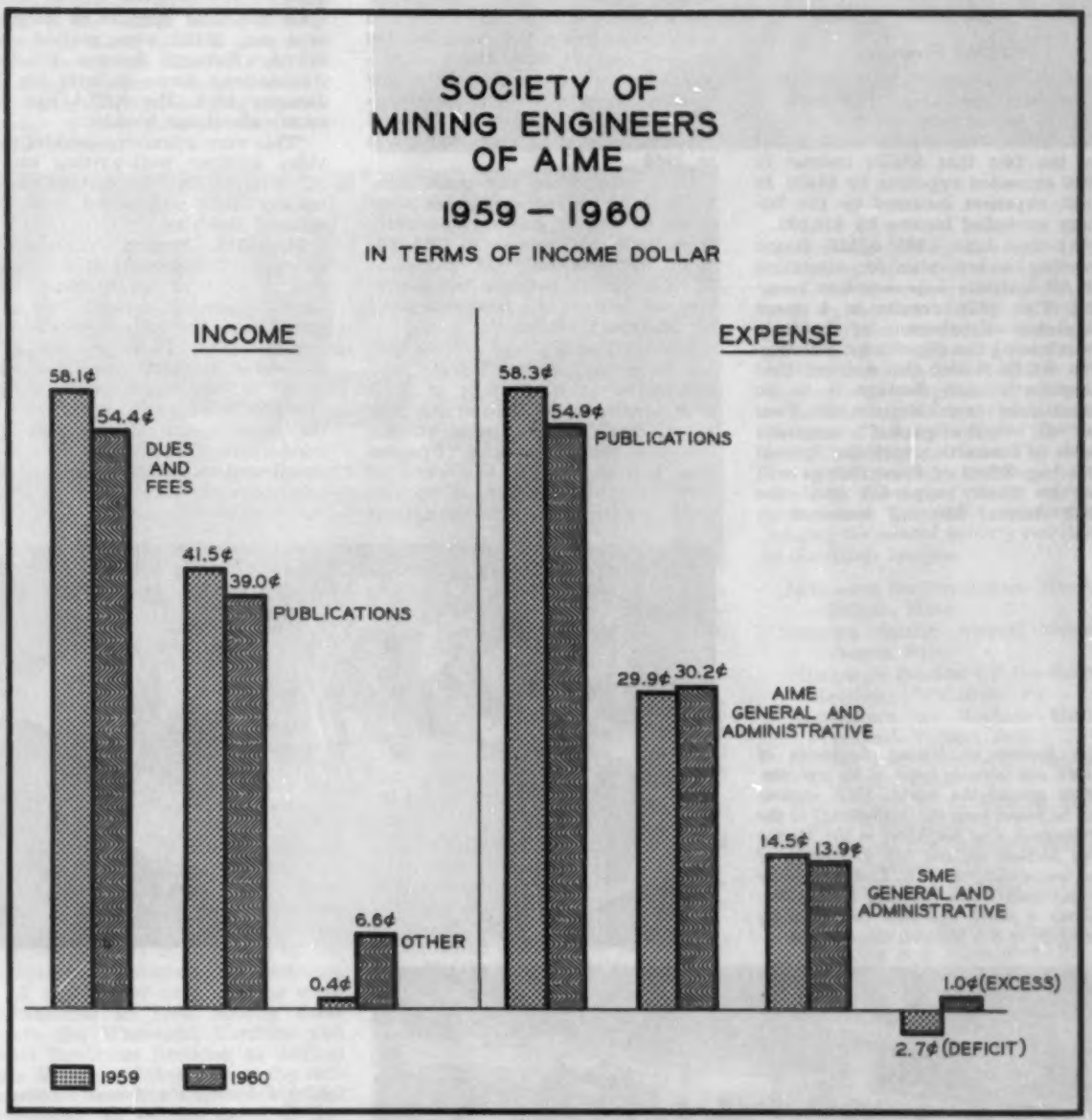
INCOME STATEMENT FOR THE YEAR 1960

INCOME

MEMBERS DUES AND FEES		
Current	$205,828	
Arrears	1,866	
New	10,208	
Entrance Fee	12,414	
Total		$230,316
PUBLICATIONS SALES		
Advertising (net)	$138,980	
Journals	11,478	
Transactions Volumes	8,349	
Reprint and Preprint Sales	7,624	
Total		$166,431
OTHER INCOME		
Dividends, Interest, and Miscellaneous		$2,857
TOTAL INCOME		$399,604

EXPENSES

MEMBERSHIP AND SECTIONS		
Local Sections, Student Chapters, Travel	$17,238	
Society Offices	40,762	
Special Membership Account	5,533	
Institute Activities	25,402	
Library Assessment	6,399	
Total		$95,334
PUBLICATIONS EXPENSES		
Journals (Advertising, Production)	$196,036	
Transactions Volumes	4,677	
Preprints and Reprints	7,489	
Directory	11,996	
Total		$220,198
GENERAL AND ADMINISTRATIVE		
Secretary's Office (New York City)	$15,720	
Secretary's Office (Salt Lake City)	10,968	
Business Office	31,703	
Pensions, Insurance, Depreciation, Misc.	21,208	
Total		$79,599
TOTAL EXPENSES		$395,131
INCOME OVER EXPENSES		$4,473*
*To AIME Surplus	$1,118	
To SME Surplus	$3,355	


SOCIETY OF
MINING ENGINEERS
OF AIME
1959 — 1960
IN TERMS OF INCOME DOLLAR
INCOME
EXPENSE
58.1¢
54.4¢
DUES AND FEES
41.5¢
39.0¢
PUBLICATIONS
0.4¢
6.6¢
OTHER
58.3¢
54.9¢
PUBLICATIONS
29.9¢
30.2¢
AIME GENERAL AND ADMINISTRATIVE
14.5¢
13.9¢
SME GENERAL AND ADMINISTRATIVE
1.0¢(EXCESS)
2.7¢(DEFICIT)
1959
1960

FROM THE SECRETARY'S DESK

The Society of Mining Engineers of AIME enjoyed a good year in 1960 in all respects. We increased our membership. Financially, income and expenses both increased—income more than expenses. Publications policies and performance moved forward, and we took a long step ahead in planning for the future of the Society within AIME.

SME Finances

It is a pleasure to report that financially speaking, 1960 was a $15,000 better year for the Society than 1959. This was brought about by the fact that SME's income in 1960 exceeded expenses by $4400. In 1959, expenses incurred by the Society exceeded income by $10,300.

At the June 1960 AIME Board meeting, a new plan for allocation of All-Institute expenses was adopted. This plan results in a more equitable distribution of Institute costs among the constituent societies. The AIME Board also decreed that henceforth each Society is to be reimbursed from Registration Fees for all "out-of-pocket" expenses made in connection with the Annual Meeting. Effect of these rulings will not be finally apparent until the 1962 Annual Meeting convenes in New York City. However, it is safe to say that this AIME Board action will vastly improve SME's financial position.

Publications

Commencing with the June 1960 issue of MINING ENGINEERING, Transactions papers, as such, were eliminated from the magazine. There was criticism of this policy from isolated sources, but to date, the membership in general has accepted the new system. Overall, in 1960 the magazine carried 816 pages of Editorial material compared with 850 pages in 1959.

In a year when our main competitors for advertising sales were down 67 and 73 pages respectively from their performance in 1959, our sales declined only 22 pages. A Pyrrhic victory perhaps, but indicative, we believe, of a favorable trend for MINING ENGINEERING.

Transactions Volume 217 for 1960 has been mailed to all those who subscribed to it. This is at least four months earlier than at any time in the past. The 512-page volume helped to ease the backlog of papers that existed at the beginning of 1960, and it includes all papers passed by the Divisions' Publications Committees through May 1960. Next year, we expect to improve on this performance by scheduling publication of Transactions Volume 220 in December 1960.

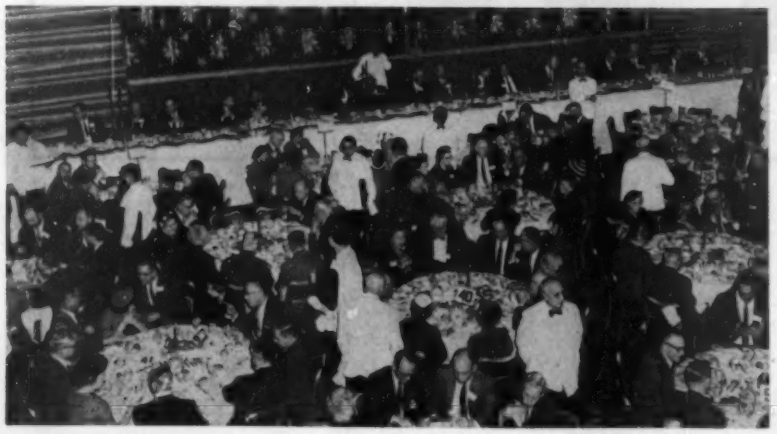
Off the press at the end of last September, the SME Careers Booklet "Opportunities Unlimited—Careers in the Mineral Industry" has received almost universal approval. About 23,000 copies are now in circulation, and requests for this booklet are received almost daily.

Of the total number of booklets sent out, 20,000 were mailed with NSTA (National Science Teachers Association) *News Bulletin No. 26*, January 1961. The NSTA has this to say about our booklet:

"This very attractive booklet provides another well-written source of information on careers in a usually little understood field—the mineral industry."

The SME Preprint Program was successfully continued at a net cost per member of 12.3¢. More than 22,600 copies of various 1960 preprints were mailed to members during the year. Those remaining at the end of the year have been supplied to an organization called "People-To-People", approved by the International Cooperation Administration. These copies have been distributed to the Earth Science Departments of universities in Latin America and Southeast Asia.

The Society of Mining Engineers of AIME can proudly boast of its representation around the world. SME sections can be found from the Netherlands to the Philippines. Our neighbors in the Mexico City Section are but one illustration of the universality of SME. Last year, their spring session was attended by the Presidents of AIME and SME as well as by members of the Mexican Government.



Each February, the Annual Meeting of AIME brings together the members of the three constituent societies of the Institute—the Society of Mining Engineers, The Metallurgical Society, and the Society of Petroleum Engineers. These meetings are highlighted by technical sessions where papers of importance to the mineral industry are presented. Other well attended functions are the business meetings and luncheons of each Division of the Society of Mining Engineers as well as the banquets of the Society and AIME.

Student AIME Chapters in the mineral engineering colleges and universities around the nation form a vital force within the Institute and the Society of Mining Engineers. Activities of these student groups cover a wide range from field trips and Chapter Meetings to participation in the AIME Annual Meeting. Awards are theirs, too—last year, members of the Missouri School of Mines and Metallurgy Student Chapter received a check from AIME for enrolling a greater number of new members than other similar chapters.

The meetings held by the Arizona Section are typical of such Local and Sectional activities held throughout the world by members of SME. A singular feature of the Arizona meeting is the gathering of the officers of the Section, of AIME, and of SME with the managers of neighboring mineral enterprises to discuss the varied topics of interest to the mineral industry with the President of the University of Arizona. This discussion is followed by a meeting of these men with the student mining engineers at the school. This, in the truest sense, is bringing the mineral industry and AIME to the college campus.

Membership

Membership-wise, 1960 was a good year for the Society of Mining Engineers when compared with the preceding year. We enjoyed a net gain of 291 members, compared to 81 in 1959. This was the result of 1152 new corporate members elected, compared to 1063 in 1959 and loss of corporate members for various reasons of 861 last year, compared to 982 in 1959.

SME Headquarters was active in a direct mail campaign to enlist new members as well as to retain those already elected to membership. Local sections around the nation cooperated fully in following up the contacts made during this campaign.

A number of new sections were established in 1960. Among these were the Wisconsin, Carolina and East Tennessee Sections, as well as the Maricopa Subsection of the Arizona Section. The Midwestern Coal Subsection of the St. Louis and Chicago Sections was organized and comes up for AIME Board approval early this year.

In an effort to interest mining students in SME, a series of posters based on illustrations from *De Re Metallica* were sent to all Mining Schools in the nation. These posters were chosen from thousands of others for a "Certificate of Merit Award" at the Employing Printers Association Exhibition in New York last January. The posters were on display from the 16th to 19th of January at the Hotel Commodore in New York City.

Meetings

SME members and staff attended and took part in many meetings at the national, regional, and local level during the year. Among these were:

1960 AIME Annual Meeting—New York City, N. Y.
Joint Meeting of SME Coal Division and the St. Louis Section —St. Louis, Mo.
Canadian Institute of Mining and Metallurgy—Toronto, Canada.
Joint Solid Fuels Conference—Charleston, W. Va.
Fifth Annual Uranium Conference —Moab, Utah
Pacific Northwest Mineral Conference—Portland, Ore.
Southwest Metals and Minerals Conference—Los Angeles, Calif.
Rocky Mountain Minerals Conference—Salt Lake City, Utah.
American Mining Congress Coal Convention—Pittsburgh, Pa.
American Mining Congress Metals and Industrial Minerals Convention and Exposition—Las Vegas, Nev.
Society of Petroleum Engineers of AIME Annual Fall Meeting —Denver, Colo.
Minnesota Section Annual Meeting —Duluth, Minn.
Arizona Section Annual Meeting —Tucson, Ariz.
Pittsburgh Section Off-the-Record Meeting—Pittsburgh, Pa.
Symposium on Surface Mining Practices—Tucson, Ariz.
Drilling and Blasting Symposium —Golden, Colo.
Washington, D. C. Section Meeting—Washington, D. C.
Midwestern Coal Subsection Meeting—Johnson City, Ill.
New York Section Meeting—New York, N. Y.
Lehigh Valley Section Meetings—Reading and Allentown, Pa.
Colorado Section Meeting—Denver, Colo.

Future Activity

At the SME Board Meeting in Denver, October 4, 1960, the Board of Directors voted to bring AIME to members around the nation via an SME Fall Meeting. A committee was appointed to implement this decision to hold an All-SME Meeting each year "in conjunction with and at the invitation of existing well-established local or regional meetings." The meetings are to be held in late summer or early fall, with the first one officially scheduled for the fall of 1962 at Gatlinburg, Tenn.—*J. C. Fox, Secretary*

THE SME OFFICERS

President-Elect

W. B. STEPHENSON

William B. Stephenson, SME President-Elect, is president of Allen-Sherman-Hoff Pump Co., Frazer, Pa. (design and application of sand pumps to mining and metal industry) the position he has held since 1956. Although a native of Minneapolis, he has long been a resident of Pennsylvania and received his mechanical engineering degree at Pennsylvania State College. He first began his association with Allen-Sherman-Hoff Pump Co. in 1938 after having worked for Cities Service Oil Co., (1933-37) and Jerguson Gage & Valve Co (1937-38). In 1948 he joined Ash Export Co. as manager, but by 1951 he was back with Allen-Sherman-Hoff Pump Co. as vice president. He is past-chairman of the Minerals Beneficiation Division of SME and served as General Chairman for the AIME International Symposium on Agglomeration which was held in Philadelphia April 12 to 14, 1961.

Past-President

A. B. CUMMINS

Arthur B. Cummins, Past-President of SME, is an internationally recognized authority on asbestos mining, mineralogy, and filtration technology of silica and diatomaceous earth. He retired last July after 36 years of service with Johns-Manville and Celite Co. which was acquired by Johns-Manville in 1930. At the time of his retirement Dr. Cummins was manager of the Central Chemical and Physical Research Dept. of the Johns-Manville Research Center, Manville, N. J. Born in 1895 in Los Angeles, he graduated from the University of Chicago in 1920 and earned his doctorate in chemistry in 1926 at the University of California. He joined the Celite Co. in Lompoc, Calif., and after its acquisition by Johns-Manville he was named manager of Celite research. Later he became manager of basic research, and in 1956 was named to the position which he occupied at the time of his retirement.

Eastern Regional Vice President

E. G. FOX

Edward G. Fox is Eastern Regional vice president and is serving a three-year term until 1964. Since 1956 he has been president of the Bituminous Coal Operators Assn., organized in 1950 to carry on labor relations with United Mine Workers of America. He began his association with the anthracite industry during his summer vacations. Upon graduating from Pennsylvania State College he took his first full-time job as an engineer with J. G. White Corp. Prior to taking his post with the Bituminous Coal Operators' Assn., he was president of Philadelphia & Reading Corp. He had been associated with Madeira Hill & Co. and Colonial Collieries Co. He also taught subjects pertaining to mines and mining practices in evening extension school of Pennsylvania State College. In 1956 he was awarded the Pennsylvania State University Distinguished Alumnus Medal.

Central Regional Vice President

D. W. SCOTT

Donald W. Scott is Vice President, Central Regional Area. He is general manager of Continental Sales & Equipment Co. A native of Minnesota, he received an E.M. degree from the University of Minnesota and a master's degree in metallurgical engineering from the University of Alabama. His career started in 1937 at Bingham Canyon, Utah, and he did research work on industrial minerals at the Southern Experiment Station of the U. S. Bureau of Mines at Tuscaloosa, Ala. He also spent 12 years at Battelle Memorial Inst. directing research.

Western Regional Vice President

H. C. WEED

H. C. Weed, Western Regional Vice President is a native of Michigan and a graduate of Michigan College of Mines. After a short stint as efficiency engineer and miner for Calumet & Hecla Mining Co., he joined United Verde Copper Co. in Jerome, Ariz. Since 1937, he has been associated with Inspiration Consolidated Copper Co. in Inspiration, Ariz., beginning his career there as shift boss, eventually becoming assistant general manager, and then general manager. Recently Mr. Weed was elected vice president and director of the company.

Treasurer

N. ARBITER

Nathaniel Arbiter is Society Treasurer as well as Director. Professor of mining engineering at Columbia University, he received his degree from Columbia in 1935. He served with the Battelle Memorial Inst. and Phelps Dodge Corp. in Arizona and New York before accepting the post at his alma mater. He has been active in MBD since its founding; has been chairman of the ECPD New York Section and the AIME Technical Publications Committee; and is one of the AIME representatives on the Engineering Societies Monographs Committee.

Secretary

JOHN C. FOX

John C. Fox, SME Secretary, graduated from Columbia University School of Mines and held a variety of jobs in the mineral industry ranging from mine laborer to assistant manager of the mining division of a large mining company. He also spent four years teaching at Columbia and has had extensive editorial experience through work for *Canadian Mining Journal*, *American Metal Market*, *Engineering and Mining Journal*, and as editor of *Mining Congress Journal* for five years. He has traveled extensively in his mining positions in the U. S., Canada, and Latin America.

THE SME DIRECTORS

J. C. BROUGHTON

S. S. COLE

W. L. DOWDEY

R. H. FEIERABEND

S. F. KELLY

John G. Broughton is State Geologist, Geological Survey of New York, Albany. Born in 1914 in Rome, N. Y., Dr. Broughton received A.B. and M.S. degrees from the University of Rochester, and a Ph.D. from Johns Hopkins University in 1940. For three years he worked for the U.S. Geological Survey. Dr. Broughton has been an instructor at Syracuse University and assistant state geologist as well as acting state geologist.

Sandford S. Cole is assistant manager of research at National Lead Co. A graduate of Alfred University where he obtained B.S. and M.A. degrees, Dr. Cole now serves as a trustee for the University. He earned a doctorate in ceramics from Pennsylvania State College in 1934. It was in the same year that he joined National Lead in the Titanium Div. Dr. Cole was research supervisor from 1945 to 1948 at National Lead.

Wayne L. Dowdey is vice president and general sales manager of The Eimco Corp. His association with the company began in 1945 as a sales engineer. Prior to joining Eimco he worked for Republic Steel, beginning in 1938 as mechanical leader and working up to superintendent of the company's iron ore concentrating mill in Spaulding, Ala.

Raymond H. Feierabend is assistant vice president of Freeport Sulphur Co. It was in this capacity that he was directly responsible for construction and development of Freeport's Grand Isle mine. For several years prior to this he was general superintendent of the company's Grande Ecaille operation. He joined Freeport as a junior engineer at Hoskins Mound, Texas, in 1942 following his graduation from Columbia University School of Mines.

Sherwin F. Kelly studied at the University of Kansas, the University of Toronto, the Sorbonne, and Ecole des Mines in Paris, and was a pioneer in the introduction of geophysical techniques in the U. S. and Canada in 1921, in association with the Schlumberger firm in Paris with which he was connected. He is president of two companies: Sherwin F. Kelly Geophysical Services Inc. and Geophysical Explorations Ltd.

Ewald Kipp, who was born in 1899, graduated from the Texas College of Mines and Metallurgy (Texas Western) in 1922 and began work for the El Paso Smelting Works, a subsidiary of American Smelting and Refining Co. He spent three years in Mexico for the Cananea Consolidated Copper Co. In 1936 he worked for the Sullivan Machinery Co. He joined his present employer, The Eimco Corp., Salt Lake City, in 1945.

Dennis L. McElroy is executive vice president of Consolidated Coal Co., with which he has been associated since 1943. In 1959 he became a director of the company and was appointed to his present post in May 1960. A graduate of West Virginia University, School of Mines, he served as a member of the faculty for a number of years.

H. E. Mauck is vice president, Freeman Coal Corp., Chicago, Ill. Born in Danville, Ill. in 1914, he received his first mining experience in his father's coal mine where he worked for three years. He then attended the University of Illinois and later Pennsylvania State University from which he graduated in 1939. Upon graduation he was associated with Pittsburgh Coal Co. before joining Olga Coal Co. in 1948.

Charles F. Park, Jr., is dean of the School of Mineral Science at Stanford University where he had gone as professor of geology in 1946. He received a B.S. degree in mining engineering from the New Mexico School of Mines in 1926, an M.S. from the University of Arizona in 1929, and a Ph.D. in geology from the University of Minnesota in 1931. He then joined the U.S. Geological Survey, remaining until 1946.

Alfred D. Rood is assistant to the vice president of Andes Copper Mining Co. and Chile Exploration Co., subsidiaries of The Anaconda Co. A graduate of Michigan College of Mining and Technology, with B.S. and E.M. degrees, Mr. Rood began as a rodman with Inspiration Cons. Copper Co. in 1925. From 1948 through 1955 he was in Butte, where he designed and developed the Kelley mine and other projects. In 1956 he went to Chile to draw up plans for Andes Copper Mining Co.'s El Salvador mine. Since his return to New York he has continued to be in direct contact with that project.

R. D. Satterley was born in Michigan and attended Michigan College of Mining and Technology, receiving B.S. and E.M. degrees. He was employed by Inland Steel Co. after graduation, successively as engineer, chief engineer, mine superintendent, and general manager of ore mines. He is now vice president and general manager of Caland Ore Co. Ltd., a subsidiary, and a director of several organizations.

E. M. Spokes is professor of mining engineering at the University of Kentucky. A native of Philadelphia, he studied at Lafayette College, the University of Kentucky, and received a Ph.D. from Pennsylvania State University. He worked for Bethlehem Steel Co. and National Lead Co. as mining engineer, foreman, and assistant superintendent. He had various teaching assignments while in the U.S. Army.

William B. Stephenson is President-Elect of SME as well as a Director. See opposite page for biography.

Frederick S. Turneaure is a professor of geology at the University of Michigan. He previously taught at Michigan College of Mines and Technology and at Harvard University. He received his B.S. from the University of Wisconsin and his M.A. and Ph.D. from Harvard University. His field experience includes work with Cinco Minas Co. in Mexico; Patino Mines & Enterprises Con. Inc.; Mauricio Hochschild, SAMI, in Bolivia; and Oliver Iron Mining Co. in Duluth. He was chairman of the Subcommittee on Fundamental Research, National Science Foundation, 1953-55.

E. KIPP

D. L. McELROY

C. F. PARK, JR.

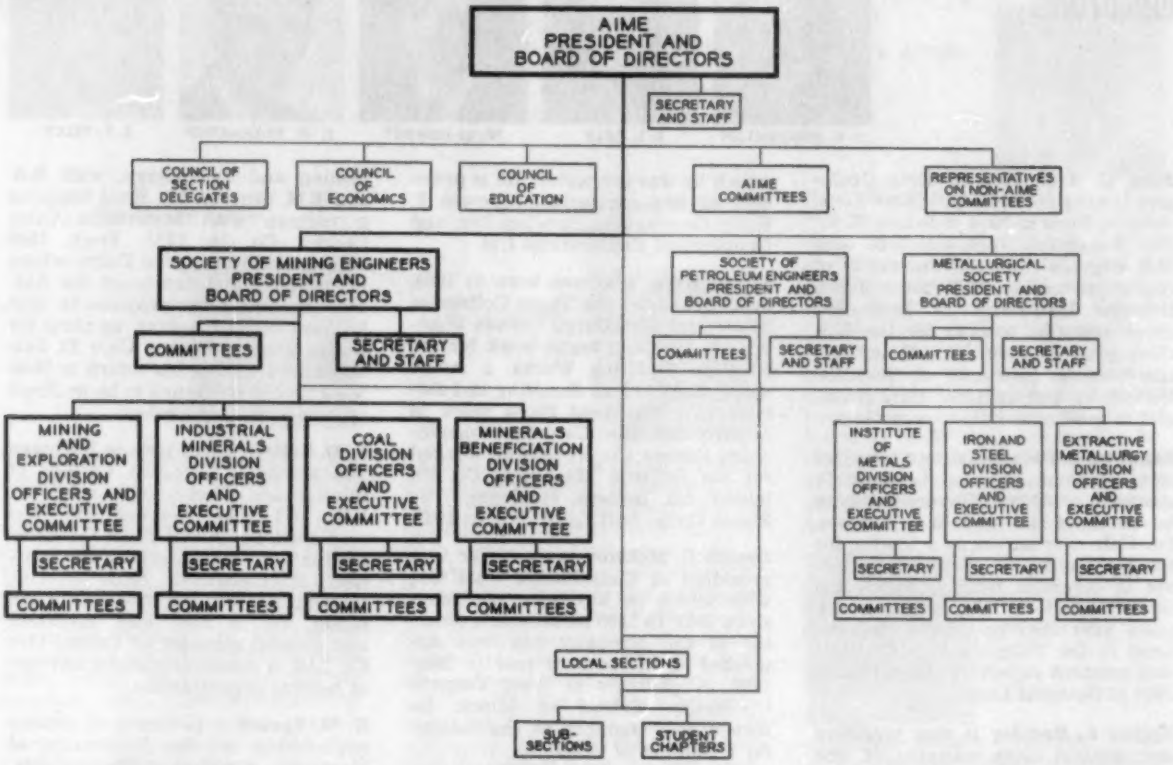
A. D. ROOD

R. D. SATTERLEY

E. M. SPOKES

F. S. TURNEAURE

HOW DOES SME OPERATE?



The Society in AIME

The Society of Mining Engineers (SME) is one of three constituent Societies of AIME, dedicated to carrying out the aims of the Institute in the field of activity relating to the Society. The Institute as a whole, and each of the Societies, is built on a broad foundation of active Local Sections. This overall organization is shown in the chart above.

The Society Itself

The Society of Mining Engineers is divided into four Divisions, all operating under the direction of the Officers and Board of Directors. SME is dedicated to the mutual exchange of knowledge and ideas leading to a higher technical and professional standing for its members. One of the principal ways in which this is done is through cooperation in an all-AIME Annual Meeting as well as sponsorship of Local Section, regional and Divisional meetings throughout the year. For example, there is a joint fall meeting with one of the AIME Local Sections which is devoted to topics of interest to those in the local industry. There are, from time to time, meetings of interest to those engaged in minerals beneficiation, coal, and industrial minerals. The mining and exploration group within SME cooperates alone or jointly with other Divisions in Local Sections, state associations, or university meetings and regional meetings of the Institute.

SME Committees

The committees of SME coordinate the efforts of the Divisions to produce the greatest amount of service to members of the Society. In the organization chart above, these committees are simply shown as one group responsible to the President and Board of Directors, but their functions are myriad—Admissions, Nominating, Program, Editorial Board, Membership, Mineral Economics, and Education. Within the committee structure of the Society the function of the Editorial Board are further subdivided: General Editorial, Transactions Editorial, and Advertising. The men serving on these committees are "watchdogs" for Society service; their goals, better service in all areas of SME affairs.

Local Sections

The Local Sections of AIME are the focal points of professionalism and the foundations upon which are built the activities of each of the Societies and the Institute as a whole. Participation in the affairs of these Local Sections promotes personal contacts and down-to-earth discussions of common problems, aims, methods and achievements. The face-to-face exchanges of information and ideas promote a climate of mutual endeavor on a personal level. This type of exchange is an essential ingredient of professionalism and growth of the individual. The starting point for such achievement is attendance at the Local Section meetings.

Divisions

In order that SME perform its functions to the fullest extent as a professional Society, based on individualism, it is divided into four Divisions to truly represent the technical interests of its members.

The Mining & Exploration Division includes members interested in underground and open pit metal mining, geology, geophysics, and geochemistry.

The Coal Division includes all members interested in the finding, mining, cleaning, and utilization of bituminous coal and anthracite.

The Minerals Beneficiation Division deals with the problems of making marketable products out of run-of-mine ore.

The Industrial Minerals Division is devoted to the industrial minerals field and functions through nine commodity committees.

There is some degree of overlapping of interests among the Divisions. This aids the unity of the Society and a member is free to attend meetings of any Division. Each Division is fully represented on the Society's Board of Directors. The officers of SME have been active in the Division which represents their professional interests. On the following four pages each of the Divisions will *speak for itself.*

W. C. McCULLOCH

Organizations made up of foremost engineers and other professional people are very important in today's fast-moving industrial and commercial world. The tremendously rapid progress in technical and scientific developments during recent years has made such organizations even more important today than in former years.

Progress and developments of this kind have taken place in the coal industry. Due to the need stressed by the extremely competitive situation within coal commerce specifically and the competition coal has to meet from other fuels generally, this progress and development may have been at an even more rapid pace in that industry than in industry generally.

Professional groups add a stabilizing, coordinating medium whereby developments, progress, and new ideas, as well as problems, can be frankly studied, compared, and discussed. They provide an effective opportunity for collaboration among members from widely scattered locations in the advancement of all types of technical and scientific undertakings.

More important yet, through meetings and the distribution of information-bearing issues, such as magazines, bulletins, and others, full enlightenment of members is maintained on all such undertakings, both those in the process of development and those which have been carried through to fulfillment and put to practical use.

Technical meetings sponsored by organizations of professional men afford an opportunity through the presentation of prepared papers and talks to familiarize members regarding new and adopted ideas and methods, at the same time affording an opportunity for discussion.

Often, from such enlightment, a member will find for himself, or the concern with which he is connected, solution to a particular problem or relief from circumstances that have been difficult and a source of economic loss. Such information may also lead to the adoption of methods that are an improvement over those being utilized, the result again being economic improvement.

The Society of Mining Engineers stands recognized as a top ethical group as compared to strictly trade groups. It offers to members all the advantages herein cited, as well as many others.

To those individuals closely associated with the coal industry, membership in the Coal Division of SME extends all of those same advantages as specifically related to that industry.

The Coal Division was organized to promote closer association of professional men connected with the coal industry, the exchange of ideas and experiences, development of new ideas and methods, and dissemination of information of common interest to the industry, the purpose of all this being to improve operations and practices so that economic conditions can, in turn, be improved.

The Division operates through an organization consisting of Chairman, Secretary, Executive Committee, and a number of other committees, each dealing with some pertinent and important phase of the activities and objectives of the Division. All of the men holding posts in this organization are devoted, capable individuals, highly interested in the affairs of the Division and their industry.

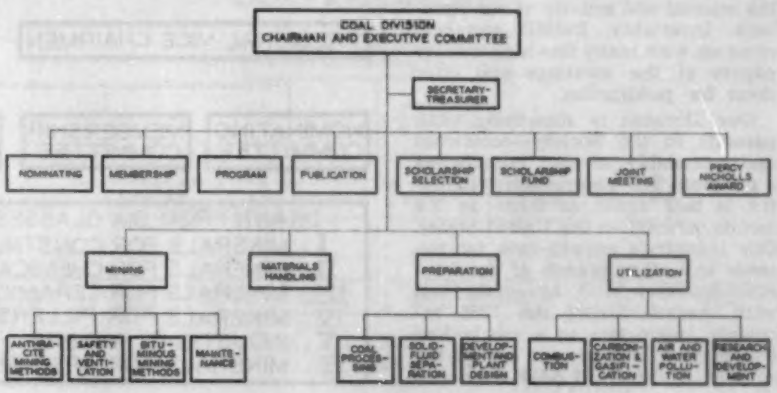
To the individual, membership means that the facilities and services of the Division become available to him for utilization as may best serve him. It means participation in the benefits and advantages enumerated in this article.

It may appear questionable to qualified members, either young or old, as to whether the need for membership can be evaluated in tangible worth. Even though tangible worth of membership may not be obvious or readily evaluated, it is such that no professional man can afford to remain separated from the organization and neglect to participate in its affairs.

Furthermore, there are intangible advantages in membership such as prestige, close association with other outstanding individuals in the same profession, and the satisfaction of participation in the extremely important and worthwhile matters with which the organization is concerned. Although these may be classed as intangible in value, they actually are immeasurable.

Finally, every professional man truly interested in his profession, or the enterprise with which he is connected, should belong to one Society of AIME. Those closely interested in the coal industry should become members of the Coal Division of SME of AIME. They will find such membership to be a distinct and invaluable asset during their professional life.

COAL DIVISION



INDUSTRIAL MINERALS NEWSLETTER

C. F. CLAUSEN

From abrasives to zircon—from search and discovery to production and marketing—leave out metals and fuels and you have the depth and breadth of the minerals industry covered by the Industrial Minerals Division. One need only to glance down the list below to envision our dimensions.

We celebrate our 26th anniversary as a Division this year. Though IndMD is one of the smaller Divisions of SME, we take pride in our ability to serve and attract many times our primary membership. We find, for example, some who cover the spectrum of activity from search to sales of a particular commodity—we find some whose main interests are in the geology or the processing of a wide range of minerals. Consequently, we have found that some of our best meetings are held jointly with other Divisions or with other professional groups.

The scope and scale of our participation in the AIME Annual Meeting and in regional meetings attest to the interest and activity of our members. Invariably, IndMD members come up with many fine high quality papers at the meetings and offer them for publication.

Our Division is something of a paradox in the Society—somewhat understandably so—but nonetheless a paradox. The non-metallics industry is half again as large as the metals industry in the United States. Our industry's growth-rate far exceeds any other branch of the minerals business. And, by comparison with metals during the 1958 recession, nonmetals as a whole had a good year. Yet we are one of the smaller Divisions of SME—and our Division's growth rate is lagging behind the industry.

We are proud of the contributions our industry has made and is making to the welfare and stability of our country and its economy. We are proud of the contributions our members have made to the mineral world—the late Oliver Bowles, Ray Ladoo, Joe Gillson, Sam Dolbear, to name only a few. There are hosts of others—real stalwarts and peers.

IndMD extends a hearty invitation to *all* in the minerals industry—particularly the nonmetallics—to look us over. We extend a special welcome to you who are not AIME members. If you are in the minerals business we know you have something to offer your fellow professionals and we, in turn, to you. In the truest sense, opportunities abound in IndMD.

Organization

The chairman directs the overall Division activity under the surveillance of the executive committee. The committee makeup includes the chairman, seven regional vice chairmen, nine members (directors), the secretary-treasurer, and the past-chairman. The regional vice chairmen will act with the chairman and secretary-treasurer as a *working board* under direction of the executive committee.

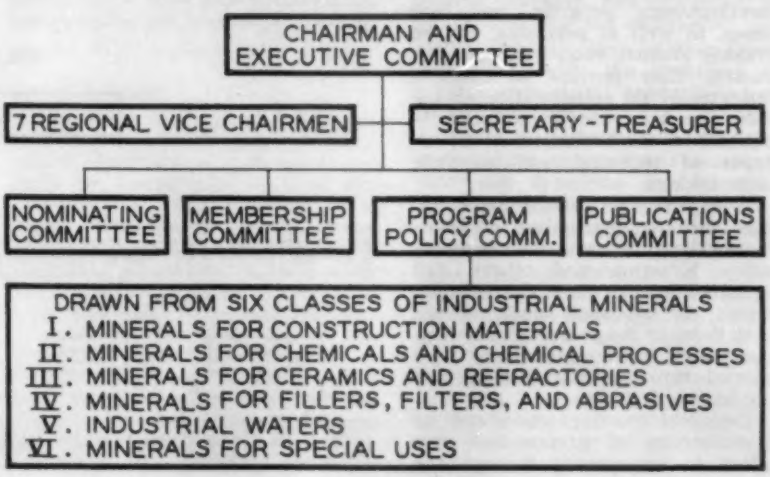
Standing committees include nomination, membership, program, and publication. We also have representation on various SME committees.

The program chairman and the chairmen and members of the commodity committees carry a heavy burden, for on them depends to a large degree, the success of Divisional activities at the Annual and regional meetings. Theirs is the job of securing papers, lining up sessions, and all the myriad details that invariably come up and must be decided upon.

Each year the Industrial Minerals Division plays a large part in the annual Institute program, with three full days of technical papers and its Divisional luncheon. Then there are regional meetings held, usually in the fall, at various spots around the country. The smaller regional affairs avoid the hub-bub and rush of the Annual Meeting, but more importantly, they go a long way toward cementing the group together and permit a more concentrated effort strictly in the IndMD field.

History: The present Division was born in 1935 when the AIME Board of Directors, at its March 15 meeting that year, formally created "an Industrial Minerals Division (Nonmetallics) in the Institute," to quote from MINING AND METALLURGY, April 1935. Actually the Division was an outgrowth of a nonmetallics committee of AIME which had been active for about a quarter of a century prior to 1935. IndMD was to provide "a needed forum for discussion and a suitable medium for the publication of technical papers of vital interest to the leaders in the nonmetallics industries."—*M & M.*

INDUSTRIAL MINERALS DIVISION


CHAIRMAN AND EXECUTIVE COMMITTEE
7 REGIONAL VICE CHAIRMEN
SECRETARY-TREASURER
NOMINATING COMMITTEE
MEMBERSHIP COMMITTEE
PROGRAM POLICY COMM.
PUBLICATIONS COMMITTEE
DRAWN FROM SIX CLASSES OF INDUSTRIAL MINERALS
I. MINERALS FOR CONSTRUCTION MATERIALS
II. MINERALS FOR CHEMICALS AND CHEMICAL PROCESSES
III. MINERALS FOR CERAMICS AND REFRACTORIES
IV. MINERALS FOR FILLERS, FILTERS, AND ABRASIVES
V. INDUSTRIAL WATERS
VI. MINERALS FOR SPECIAL USES

N. PLUMMER

Membership in the Society of Mining Engineers of the AIME is an indication of professional identity and the mark of the individual who wishes to contribute with pride to the growth of his profession. Such growth is a dual proposition: as the Society (and Institute) gain prominence in our advancing technological culture, the individual member is enabled to expand his own horizons and skills by his association with a strong professional group. An active part in SME affairs may be gained by direct association with a division of one's choice such as the Minerals Beneficiation Division.

The MBD, through its national and regional meetings and its related publications, is the paramount organization in the U. S. for presentation and exchange of technical information relating to the processing of ores. A vital part of this exchange is embodied in committee activities by which MBD members may gain professional recognition quite apart from publishing technical papers. Membership on MBD technical committees is open to all MBD affiliates and appointments to these committees are based on an indicated willingness to work as a member of a committee team. A letter to your Division Chairman, indicating a desire to serve, will provide the opportunity for association with the MBD administrative group. A demonstrated ability through these activities leads to positions of greater responsibility. This is an effective route to national professional recognition.

The Minerals Beneficiation Division is a dynamic part of the SME and AIME. Its strength arises from the dedicated efforts of individuals with a common interest in a professional field. It has gained international stature as may be seen by the number of foreign papers presented at our Annual Meetings and the additional ones published in our *Transactions*. The Division also sponsors special conferences of an international scope and joins other Divisions of the AIME in joint programs of mutual interest. Regional and local groups, within the U. S., provide even closer bonds among our members to promote individual professional development.

As with almost any organization, each member receives benefits roughly proportional to his own contributions of effort; thus the premier standing of MBD attests to the fact that many renowned engineers and scientists have aided in its growth. We welcome new members and urge all to take part in our activities. If you wish to publish the results of your technical work, or to develop skills in professional administration, or to improve your engineering abilities, or merely to enjoy the stimulating association with engineers of similar interests, MBD has a place for you.

History: The Minerals Beneficiation Division of AIME came into being as a formal part of the Institute at the Feb. 16, 1948, meeting of the Board of Directors in New York. Forerunner of MBD was the Milling Methods Committee of AIME.

Actually the Division was already operating, since it had a fullfledged schedule of sessions and social events at the Annual Meeting then taking place. To quote briefly from Professor Arthur F. Taggart's colorful, well written meeting resume:

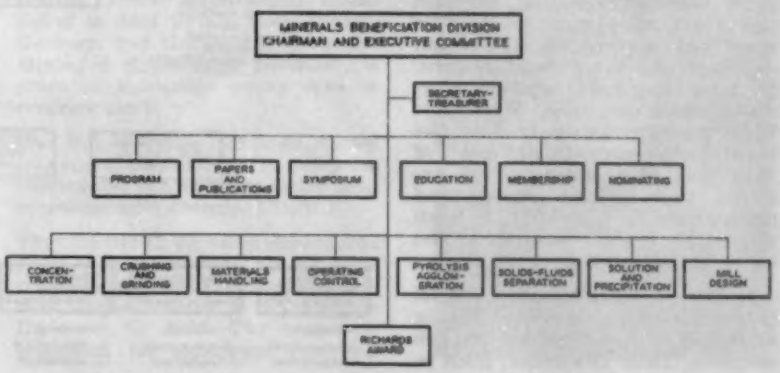
"In potential for service to members of the mineral engineering profession the word Division above [in the title of the report, MINING & METALLURGY, March 1948] marks the most important incident in many years. Thanks are due to Ted Counselman for the original idea and for skillful and unremitting work in carrying it through; to Jack Myers for wholehearted enlistment in the fight, and to the Lord, I guess, for endowing him with the capacity to smooth the ruffled feelings it engendered; and to The Dorr Co. and to the Tennessee Copper Co. respectively for sympathetic recognition that these key men had company work so well organized they could properly devote company time, supplies, and secretarial aid to the campaign."

The first Division luncheon was also held in that momentous year, 1948, and at the time announcement was made of the availability of funds for an annual presentation of the Robert H. Richards Award by AIME in recognition of meritorious achievement in ore dressing.

1948 was indeed a banner year, for it also saw the introduction of an event of fame or infamy, depending on your viewpoint—or time of day—or both. The *M & M* Annual Meeting reporter put it this way, in describing that first Scotch Breakfast: ". . . a new standard in matutinal gastronomy." Today the Scotch Breakfast and Division luncheon are Annual Meeting traditions, playing to a capacity audience.

But our History does not end here. 1961 will see another laurel given to MBD. In September, engineers from all parts of the globe will gather in Denver to attend the symposium observing the 50th Anniversary of Froth Flotation, sponsored by our Division and symbolic of the activities of the men of MBD.

MINERALS BENEFICIATION DIVISION



ROCK IN THE BOX

Mining & Exploration Division

J. G. HALL

The Mining and Exploration Division of SME serves those whose interests are the exploration for and removal from the earth of metallic and nonmetallic ores. Formerly the Mining, Geology, and Geophysics Division of AIME and SME, its members consist of underground and open pit mining engineers, geologists, geophysicists, and geochemists and geologic engineers.

Among the benefits and services M & E offers its members are:

1) Just as the trend in the mining industry is toward integration so has M & E increased its own policy of integration. The miners and exploration people are carrying out increasingly coordinated functions rather than operating as separate units as they did in the past.

2) The programs the Division sponsors at AIME Annual Meetings reflect this trend. The various program committees during the past few years have tried to schedule more joint sessions for all Division members and fewer total sessions. By scheduling fewer sessions, especially concurrent ones, M & E'ers have the opportunity to hear the latest developments in all aspects of their field of engineering. For example, open pit or underground miners have an opportunity to learn about the newest techniques and tools for exploration.

3) MINING ENGINEERING, *official* publication of the Society of Mining Engineers of AIME, serves Division members. Their newsletter, *Rock in the Box*, is carried in most issues during the year. This newsletter keeps members abreast of Division business, helps acquaint M & E'ers with their officers and projects of their part of SME, and serves as a sounding board for ideas and interests. Letters to the editor, published last year, informed miners and explorers of technical highlights of a number of non-AIME meetings. These were meetings most Division members could not attend. Actually, any member can use *Rock in the Box* as a "sounding board" for a pet project or idea or grievance just by addressing a letter to the editor.

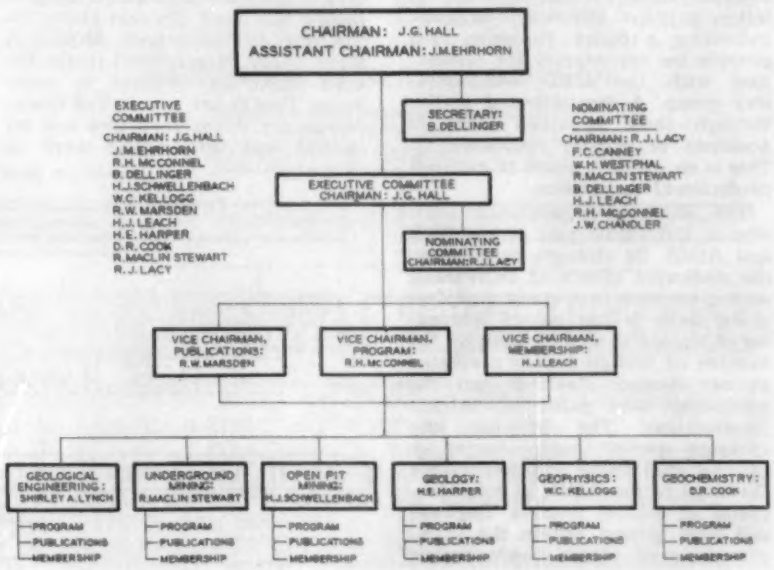
MINING ENGINEERING serves M & E'ers in many other ways. Numerous articles throughout the year are devoted to topics within the Division's field of interest. An *Abstracts* column not only gives handy reference digest of papers in a given issue but also those presented at meetings of interest to SME members. The *Mineral Information Section* gives data on current technical literature from leading publishers, state agencies, and many foreign countries.

History: The Division (under the name Mining, Geology, and Geophysics Division of AIME) was founded in the fall of 1949, an outgrowth of the activities of several former committees of the Institute. In 1958 the name was changed to Mining and Exploration Division and a certain amount of reorganization was effected in order to both broaden the scope of the Division and provide greater cohesion.

Organization: Today, M & E's basic organization is the Unit system, one each for open pit mining, underground mining, geology, geophysics, geochemistry and geologic engineering. However, to preserve the integration attained by the Division, the various committees of each unit (program, publications, membership) are responsible to a Division vice president who coordinates the activities of the six units.

Of interest to all members of the M&E Division was the invitation to the Geological Engineers to membership in AIME, through SME, as a unit committee in the M&E Division. On March 3, 1961, discussion of this proposal with the Geological Engineers resulted in their acceptance to be the sixth unit committee in our Division.

MINING AND EXPLORATION DIVISION, 1961



SME OFFERS PROFESSIONAL RECOGNITION

Through AIME and SME, individual engineers attain professional recognition when they are named recipients of major awards. This page is devoted to the awards of interest to members of SME. The captions accompanying the pictures explain what aspect of professionalism the award represents.

The James Douglas Gold Medal recognizes distinguished achievement in nonferrous metallurgy including both beneficiation of ores and alloying and utilization of nonferrous metals. (Above.)

The William Lawrence Saunders Gold Medal recognizes distinguished achievement in mining other than coal. The term "mining" includes the production of metals and nonmetallic minerals. (Above.)

The Charles F. Rand Memorial Medal is awarded at such a time and under such rules as may be determined by the Board of Directors of AIME for distinguished achievement in Mining Administration. The term "mining" is defined in its broader sense to include metallurgy and petroleum. (Above.)

The Erskine Ramsay Gold Medal is awarded in recognition of distinguished achievement in coal mining including both bituminous and anthracite coal. (Above.)

The Robert H. Richards Award recognizes achievement in any form which unmistakably furthers the art of minerals beneficiation in any of its branches. (not illustrated.)

The Rossiter W. Raymond Award (in the form of a certificate and check) is given annually for the best paper published by a member of the Institute under 33 years of age. Not only technological content but literary quality is considered.

The Robert Peele Memorial Award (in the form of a certificate), established in 1954 by the then Mining, Geology, and Geophysics (now the Mining & Exploration Division), is given to encourage young men in creative work.

The Hal Williams Hardinge Award was recently established to recognize outstanding achievement in the field of industrial minerals. (Right.)

The Daniel C. Jackling Award and Lecture was instituted by the Mining, Geology, and Geophysics Division (now Mining & Exploration Division) in 1953. The award is presented for significant contributions to technical progress in the fields of mining, geology, and geophysics. The recipient is the Jackling Lecturer at the AIME Annual Meeting. (Bottom left.)

In addition to these awards presented in recognition of achievement on a professional basis, each of the constituent Societies of AIME may give annually an award to students for papers submitted in the Annual National Prize Paper Contest. SME may give an award of $100 each for a paper in the graduate class and for one in the undergraduate class. These presentations are made at the welcoming luncheon during the Annual Meeting of the Institute.

The Institute also cooperates with the other Founder engineering societies in the presentation of certain awards:

The John Fritz Medal is awarded for notable scientific or industrial achievement.

The Alfred Nobel prize is given for a technical paper of particular merit accepted by the publication committee of any of the four—AIME, ASME, AIEE, and the Western Soc. of Engineers—for publication, in whole or in abstract, in any of their respective technical publications, provided the author, at the time the paper is accepted in practically its final form, is not over 30 years of age.

The third joint award of the Founder Societies is the Hoover Medal. Named in honor of Herbert Hoover, Past-President of AIME and former President of the United States, the medal is awarded for distinguished public service by an engineer.

The Percy Nichols Award is given for notable scientific or industrial achievement in the field of solid fuels. Given under the joint sponsorship of AIME and ASME, the Award is presented at the Annual Joint Meeting of the Coal Division of SME and the Fuels Division of ASME.

SOCIETY AND AIME SERVICES

Described below are some of the services provided by the Society and the Institute and available to you as a member of SME of AIME. They range from papers and books to personnel service.

Preprints—As a service to its members, the Society of Mining Engineers preprints papers presented at the Society meetings. In 1961 approximately 101 Annual Meeting papers, presented at St. Louis in February, were preprinted and available on a coupon basis to members and nonmembers of the Society of Mining Engineers.

In order to make this program financially feasible, preprints are distributed on a coupon basis. Each member of SME receives with his annual dues bill a book of five free coupons which entitles him to five preprints. If he should attend the Annual Meeting, he receives as part of his registration a second book of five free coupons entitling him to five additional preprints. Thereafter, coupon books are available to members for $5 per book of ten coupons. Each coupon is redeemable for one preprint. The Society also sells books of ten coupons at $10 per book to nonmembers. These coupons are again redeemable for preprints.

In addition to the papers preprinted for the Annual Meeting, the Society is also preprinting papers presented at some regional meetings. In 1960 the AIME papers presented at the Joint Solid Fuels Conference of AIME and ASME were preprinted and available to members and nonmembers on a coupon basis. Also available were papers presented at the September meeting of the Coal Division and the AIME St. Louis Section. During the forthcoming year, SME is hoping to expand its preprint coverage of meetings.

Books—In addition to the professional and personal contact function of AIME, the Institute has a major objective the dissemination of technical information of varying kinds. One method of so doing is publication of a monthly technical journal, MINING ENGINEERING, by the Society of Mining Engineers. As part of its ever-expanding publications program, the Society of Mining Engineers in 1960 brought out an enlarged TRANSACTIONS (Vol. 217). In addition to 23 papers reprinted from MINING ENGINEERING magazine, the book contained 49 papers never before available except in preprint form. Volume 217 was three times the size of previous volumes. Publication of TRANSACTIONS in conjunction with the monthly magazine enables SME members to keep pace with the latest technical literature in their fields.

In addition to the annual *Transactions* volume, AIME publishes from time to time books of interest to those engineers in the minerals industry. For example, *The Porphyry Coppers in 1956* edited by A. B. Parsons, was a recent publication of the Institute. *Economics of the Mineral Industry* was a 1959 publication of AIME. Published early in 1960 was a third revision of *Industrial Minerals & Rocks*, edited by J. L. Gillson, 1960 AIME President. A long-needed revision of two earlier volumes, this 900-some page book is truly a monumental contribution to technical literature. From time to time AIME issues an available book list for the information of its members. Members of SME can obtain these books (and those of other publishers) at a discount.

Library—The Engineering Societies Library is located physically in the Engineers Building, home of AIME and the other Founder Societies. It is a department of the United Engineering Trustees, a corporation of which each of the five Founder Societies is a member. Through their membership in UET, the Societies support the Library. ESL is, of course outstanding in the fields of its Founder Societies—civil, electrical, mechanical, mining, metallurgical, petroleum, and chemical engineering—but the over 175,000 volumes in the Library cover all branches of engineering, primarily on the level of the graduate practicing engineer. In addition to these reference works, the Library currently receives over 1500 periodicals from all parts of the world.

The reading room of the Library is available to anyone, whether he be a member or not of the Founder Societies.

The Library offers special services such as preparation of bibliographies; literature searches; and translation, photoprint, and microfilm copying of material contained in the Library. Such services can be ordered by mail. The Library will be glad to furnish a brochure of its services and charges upon request.

ESPS—The Engineering Societies Personnel Service Incorporated is a nonprofit, self-supporting national employment service cooperating with various engineering societies, of which AIME is one. With offices in Chicago, New York, and San Francisco, engineering employment services are available for employer and employe. The range of jobs listed for engineers includes every field of industry and government from production, administration, consulting, to editorial and sales. ESPS carries a listing of available engineers as well as positions open.

EJC—Engineers Joint Council is a federation of Professional Societies whose memberships total a quarter of a million engineers (AIME is a constituent society). EJC is dedicated to the betterment of the nation and to the professional and sociological development of the individual engineer. Societies in special fields serving members in their particular areas by EJC, represents the broad engineering profession and works for engineering by promoting sound public recognition (*image*, if you like) of the engineer.

Some of the areas to which EJC's jurisdiction extends are national manpower policy, engineers' employment conditions in industry, science and engineering education, secondary and technical school education, national resources policies, international standards, labor management relations, and developments such as nuclear energy.

The fourfold constitutional objectives of EJC are 1) to advance the general welfare of mankind through the available resources and creative ability of the engineering profession, 2) to promote cooperation among the various branches of the engineering profession, 3) to advance the science and profession of engineering, and 4) to develop sound public policies respecting national and international affairs wherein the engineering profession can be helpful to the services of the engineering profession.

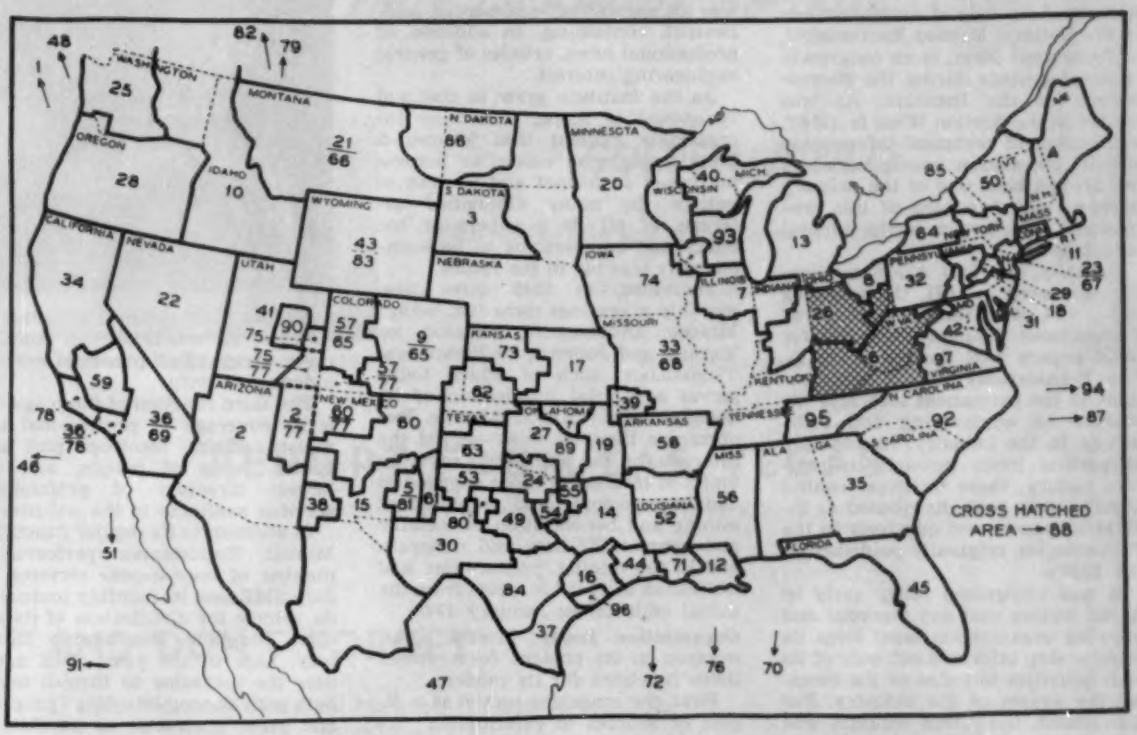
To achieve these objectives, EJC acts as an advisory and coordinating agency to work out and study matters of mutual interest to the constituent societies and to recommend parallel action by them. EJC represents the constituent societies of the council in instances in which the constituent societies deem such joint representation desirable. EJC also administers, on behalf of the engineering profession, those activities which are authorized by a majority of the societies.

Several major annual events are held under the auspices of EJC. One is the general assembly, normally scheduled for January, which brings engineers together with world authorities on subjects of broad interest to the engineer in the profession. The Nuclear Congress, first held in 1955 and again in 1957, became in 1958 an annual event controlled by EJC's permanent policy committee on nuclear congresses. In addition to these events other conferences are arranged as the need arises. By joining the Society of Mining Engineers of AIME, an engineer can participate in the conferences and programs of Engineers Joint Council.

AIME LOCAL SECTIONS

Professional Activities at Your Doorstep

AIME Local Sections cover the U.S. and many other parts of the world. Members of the Society of Mining Engineers find a professional group—their Local Section—in key areas throughout the country. These Local Sections are served by AIME headquarters, but elect their own officers and conduct their own affairs, thus providing the broad base from which the strength of AIME stems.



Numerical Code to Local Section Map

1 Alaska
2 Arizona
3 Black Hills
4 Boston
5 Carlsbad Potash
6 Central Appalachian
7 Chicago
8 Cleveland
9 Colorado
10 Columbia
11 Connecticut
12 Delta
13 Detroit
14 East Texas
15 El Paso
16 Gulf Coast
17 Kansas
18 Lehigh Valley
19 Mid-Continent
20 Minnesota
21 Montana
22 Nevada
23 New York
24 North Texas
25 North Pacific
26 Ohio Valley
27 Oklahoma City
28 Oregon
29 Pennsylvania-Anthracite
30 Permian Basin
31 Philadelphia
32 Pittsburgh
33 St. Louis
34 San Francisco
35 Southeast
36 Southern California
37 Southwest Texas
38 Southwestern New Mexico
39 Tri-State
40 Upper Peninsula
41 Utah
42 Washington, D. C.
43 Wyoming
44 Spindletop
45 Florida
46 Philippine
47 Mexico
48 Southwestern Alaska
49 West Central Texas
50 Adirondack
51 Peru
52 Lou-Ark
53 South Plains
54 Fort Worth
55 Dallas
56 Mississippi
57 Colorado Plateau
58 Arkansas
59 San Joaquin
60 Central New Mexico
61 Hobbs
62 Hugoton
63 Panhandle
64 Niagara Frontier
65 Denver Petroleum
66 Billings Petroleum
67 New York Petroleum
68 Illinois Petroleum Basin
69 Los Angeles Basin
70 Eastern Venezuela Petroleum
71 Evangeline
72 West Venezuela
73 Great Bend
74 Upper Mississippi
75 Uranium
76 Caracas
77 Four Corners
78 California Coastal
79 CIM-AIME Calgary
80 Snyder
81 Roswell
82 CIM-AIME Edmonton
83 Wyoming Mining & Metals
84 Balcones
85 Hudson-Mohawk
86 Williston Basin
87 Saudi Arabia
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MINING ENGINEERING — SME's MAGAZINE

MINING ENGINEERING is the official magazine of the Society of Mining Engineers of AIME. Published monthly, it is one of the leading publications serving the mineral industry. As a member of SME you receive a subscription.

History: As is true of many features of the Society, MINING ENGINEERING, in its present form, is an outgrowth of developments during the 90-year history of the Institute. As was quoted in the Section *What Is SME?*, publication of technical information and its circulation among members has always been one of the primary purposes and functions of this professional organization in the mineral industries.

Actually, the first AIME publication appeared in 1871, the founding year, and was the first of many *Transactions* volumes (Vol. 220 for SME papers will appear in 1961). The *Transactions* contain contributions to the permanent technical literature on engineering and technology in the industry. In addition, at various times throughout Institute history, these technical contributions have been distributed as individual papers and quarterly in the *Technologies*, originally published in the 1930's.

It was recognized fairly early in AIME history that any vigorous and growing organization must keep its membership informed not only of its own activities but also of the newsworthy events of the industry. For this reason, the AIME *Bulletin* was started in 1905. At first bimonthly, it became a monthly in 1908. During its years of publication, the *Bulletin* contained such data as news of Institute meetings and business affairs, lists of new members, various announcements and notices of general interest, and advertising.

MINING AND METALLURGY became its hardy successor (formally in January 1920) as the regular monthly magazine of the Institute. For many years this publication served as a cohesive element in AIME affairs; it went to all members and contained news material of interest to all. It was an aggressive, commercial publication, containing, in addition to professional news, articles of general engineering interest.

As the Institute grew in size and broadened in scope, it became increasingly evident that MINING & METALLURGY was either to become too broad in format and content to satisfy the many diversified interests of all its members or too bulky and cumbersome to be economically feasible in the future.

Therefore, in 1949 three new monthly magazines came into being: MINING ENGINEERING, JOURNAL OF METALS, and JOURNAL OF PETROLEUM TECHNOLOGY, each of which today serves as official publication of its Society within AIME. MINING ENGINEERING then—as now—served the interests of the industry: covering topics of interest to those engaged in "mining geology and exploration, mining and beneficiation of metallic and nonmetallic ores and minerals, and in the mining, preparation, and utilization of coal," to quote from the initial editorial in January 1949.

Organization Today: MINING ENGINEERING in its present form serves three functions for its readers.

First, the magazine serves as a digest of sources of information. Included in the front section are notices of coming events; jobs; a comprehensive survey of current literature in the field, published here and abroad; abstracts of papers published and presented at meetings; reports of recent developments and publications by manufacturers; and in each issue, a summary of industry news.

MINING ENGINEERING provides, as its core, an article section containing coverage of all phases of mineral industry activity.

The third function of the magazine is its coverage of professional and society affairs, meetings past and future, news of people, and the largest directory of professional services available to the industry.

In addition to its regular functions, MINING ENGINEERING performs a number of *once-a-year* services. In July SME uses its monthly journal as its vehicle for distribution of its annual, complete Membership Directory. Late in the year, SME again uses the magazine to furnish members with as complete data (program and paper abstracts) as possible on the forthcoming Annual Meeting, held each February.

MINING ENGINEERING also serves members of the Society by presentation of an *Annual Review*, devoted to summary of industry developments and progress in the year past as well as prognostications for the future.

SME's Programs: Its monthly journal is part of the overall Society publications program which includes preprints, magazine, and the annual *Transactions* volume.

Each of these three media fulfills a specific role: 1) Preprints are intended for rapid dissemination at low cost of information presented at meetings. The Preprint program is set up so that not only members attending meetings, but also those who could not, can have the text of papers presented as quickly as possible. 2) The monthly magazine performs the three functions outlined above, as well as providing a media for "special" information or service. 3) The annual *Transactions* fulfill their historic role as reference volumes and a consistent series in the permanent technical literature of the mineral industries.

Thus, through its publications, SME serves you, its members.

SME BULLETIN BOARD

Reports of Your Technical Society

BROWN PALACE HOTEL—DENVER

GOLDEN JUBILEE

Plan now to take part in the Commemoration of 50 Years of Froth Flotation in the U.S.

For program see page 616

REPORT FROM LAS VEGAS

Southwest Minerals Industry Conference

(page 623)

AND DON'T FORGET

Joint Meeting, Industrial Minerals Division AIME-CIM
Ottawa, Ont., Canada see page 617

Mine Rescue Contest
Charleston, W. Va. see page 620

Meet your New Editorial Director — page 616

For Information on AIME Transactions (Mining) Vol. 220, 1961 see page 534.

OUR WINDOW ON MOSCOW

See Around the Sections, page 625, for report on the construction industry in the USSR.

SME Preprint List page 540

Members can now purchase SME Jewelry **See ad on page 563**

Beall Named As Editorial Director

John V. Beall has been named Editorial Director of MINING ENGINEERING to succeed Rixford A. Beals (See p. 627) who leaves the post after nine years of outstanding service. Many members will recall that Mr. Beall (pronounced *bell*) is not new in AIME staff circles having served in various editorial and administrative capacities from 1948 to 1953, going back to the days of *Mining & Metallurgy*. In the eight years since he was last with us he has been engaged in exploration and mining in various parts of the world. Most recently he comes from Andes Copper's new El Salvador block-caving mine in northern Chile. Prior to that he was in charge of bauxite exploration in the Amazon basin for Kaiser Aluminum & Chemical Company. Mr. Beall spent four years with the U.S. Atomic Energy Commission, two of which were in Morocco as exploration manager.

Program Set for Froth Flotation Commemoration Meeting in Denver

Plans for the Commemoration of the 50th Anniversary of Froth Flotation in the U.S. have reached the stage where a preliminary program can be given. The meeting, to be held in Denver, will run from September 17 through September 20. Registration begins Sunday, September 17 at the Brown Palace Hotel. There will be a Get-Together (Cash Bar) during the registration hours from 2 to 6 pm. Registration will continue throughout the conference during the morning hours.

Monday, September 18—9 am to Noon

Technical Session I

New and Future Applications and Uses for Flotation
Cosmopolitan Hotel

Flotation of Micro-Organisms by *A. M. Gaudin*, Massachusetts Institute of Technology.

Future Flotation Research by *D. W. McGlashan*, Montana School of Mines.

Froth Flotation of Ion-Exchange Resins and Its Application to Practice by *Roshan Bhappu*, New Mexico Bureau of Mines.

Flotation Aids Cyanidation of Pachua Ores by *R. R. Bryan*, Russell Bryan & Associates.

New Developments and the Future of Flotation in Italy by *Luigi Usoni*, Consiglio Nazionale Helle Ricerche, Rome, Italy.

Monday, September 18—12:15 pm

Welcoming Luncheon—Brown Palace West

Monday, September 18—2 to 5 pm

Technical Session II

Kinetics of Flotation
Brown Palace West

Measurement of Zeta Potentials by Radial Streaming Method by *Norman Street*, University of Illinois and *P. R. Stewart*, Shell Oil Co.

Influence of Radiation in Flotation by *A. Gotte*, Hochschule Aachen, Aachen, Germany.

Hydrolytic and Ion Pair Absorption Models for Collectors in Flotation by *Melvin A. Cook*, University of Utah.

Refinements in Methods of Determining Flotation Rates by *A. Jowett*, University of Leeds, Leeds, England.

Flotation Machines by *Robert Merritt*, Colorado School of Mines Research Foundation.

Monday, September 18—6:00 pm

Cocktail Party—University Club

Tuesday, September 19—9 am to Noon

Technical Session III

Present Flotation Practices
Cosmopolitan Hotel

Present Flotation Practice in the Coal Industry in Great Britain by *John L. Lewis*, Unifloc Ltd., Swansea, Wales.

Recent Developments in the Flotation of Oxidized Ores of Copper, Lead, and Zinc by *M. Rey*, de Penarroya, Paris, France.

Molybdenum Flotation by *R. W. Hernlund*, Pima Mining Co.

Phosphate Flotation by *I. M. Le Baron*, International Mining and Chemical Corp.

Flotation of Iron Ore by *Louis Erck*, Cleveland-Cliffs Iron Co.

Tuesday, September 19—2 to 5 pm

Technical Session IV

Milling Circuits Design and Effects on Mining and Smelting
Brown Palace West

Flotation Evolution since 1910 by *E. J. Pryor*, Imperial College, London, England.

Dezincing of Lead Concentrates at the Sullivan Concentrator by *H. J. Chalmers*, Consolidated Mining & Smelting Co. of Canada, Ltd.

Design of the Flotation Section by *O. W. Walvoord*, O. W. Walvoord Inc.

Segregation Process by *Carl Rampacek*, USBM.

Anionic vs Cationic Flotation of Potash by *H. N. Clark*, Potash Co. of America.

Tuesday, September 19—6:00 pm

Cash Bar, Banquet, and Dance
Brown Palace West

Wednesday, September 20—7:00 pm

Scotch Breakfast—Cosmopolitan Hotel

Wednesday, September 20—9 am to Noon

Technical Session V
Flotation Mill Control
Cosmopolitan Hotel

Instrumentation—the Overall Effects on Flotation Milling by *J. E. Lawver*.

Flotation Theory and Mill Control by *C. H. G. Bushell*, Consolidated Mining & Smelting Co. of Canada Ltd.

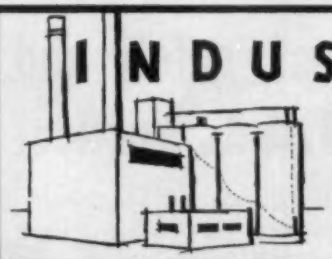
Ore Microscopy in Flotation by *G. C. Amstutz*, University of Missouri School of Mines.

X-Ray Analysis of Mill Products by *Anaconda staff* and *El Salvador staff*.

Controlling Coal Flotation Circuits by *W. M. Bertholf*, New Mexico Institute of Mining and Technology, Bureau of Mines and Mineral Resources.

Technical Efficiency of Concentration Operation by *J. R. Stevens*, UKAEA, Harwell, England and *D. N. Collins*, Warren Spring Laboratory, England.

(Continued on page 620)



INDUSTRIAL MINERALS NEWSLETTER

Programming

Our hard-working Program Policy Committee advises that an interesting group of papers is beginning to shape up for the February meeting in New York. Some of the titles of presentations are: *Trends in Graphite Use and Supply, New Beryllium Ore Developments, Water Demands of the Mineral Industry, Trends in Demand for and Supply of Gem Stones, Another Look at the Rare Earths Picture, Outlook for Electrical Mica, Natural vs Synthetic Minerals for Specialities* (abrasives, gems, optics, electronics, etc.), and *Water Use in Mining and Processing Phosphate Ore.*

Ray Kazmann advises that he and his Program Policy Committee are earnestly searching for and soliciting from you new ideas and possible authors—we need your help. Mr. Kazmann's address is: **P. O. Box 451, Stuttgart, Ark.**

Glen Canyon Dam

Any mining engineers who pass near Glen Canyon Dam will find that its construction involves much more mining engineering than most of us realize. Excellent aggregates are produced from deposits that would not have been given a second glance a few years ago. Washing, screening, and sink-float equipment produces acceptable aggregate. Then there are tunnels for river flow as well as access of personnel to the river bottom. The spillway is a giant raise that is cut and lined with remarkable precision. Puzzolano comes from near Kingman, and cement from a new plant near Clarkdale.

Reflections on Water

Water is fast becoming one of the nation's most controversial minerals. Obtaining the maximum financial benefit from the use of available water is becoming of increasing concern to many. That it is of importance to the mineral industry was demonstrated in the Industrial Waters session at the annual meeting in St. Louis. Orville Mussey, in his paper on the beneficial use of water in the mining and milling of iron ore, pointed out that in that industry the value added by the use of 1000 gal of water is about $7.00 as compared to $1.19 in the supplemental irrigation of cotton. The greater dollar return from water used in the iron industry than in the irrigation of crops is a significant factor of importance to water development planners. Similar comparisons were made last year in a paper presented at New York for copper by the Engineering Dept. Staff, Western Mining Divisions of the Kennecott Copper Corp.

Nathaniel Wolman presented a paper on future water demands that indicated that the cost of water to the user has remained reasonably constant (either due to subsidies or more efficient production) and that the use of water per unit of industrial or agricultural production has remained about the same during the past decade. The Paley Commission water projections, he advised, are still fairly well on target. Where the price of water to the consumer increases per unit of production, water saving devices and procedures are more apt to be installed.

The hydrate process of desalinization of water was discussed in detail by V. C. Williams. He had just received his patent on the process the week previous to the St. Louis meeting. This process offers another promising method of attack on water desalinization.

Conflicts in water use will likely become of increasing concern to the mineral industry, according to Tom Maddock of the USGS. In his paper on mining vs. reservoirs, presented in the *Conflicts Symposium*, he cautioned that with adequate cooperation in the planning stages, both water development and continued mine production (i.e., mineral utilization) can be achieved. The announced national policy provides for a multiple use theory in respect to all resources [P.L. 167, the Multiple Surface Act., 84th Congress, 1st Session]. The mining engineer, Maddock pointed out, must be ready to present his case forcefully to show the significance of his industry as related to water developments, and be prepared to take part in water resources planning. [Only in this way will he get his interests adequately considered and provided for. L. W. D.]—*Leon W. Dupuy.*

Plan Now for the CIM-SME Joint Meeting in October

October may seem a long way off to you right now, with summer just beginning, but it isn't too early to start making your plans to attend the Joint Meeting of the Industrial Minerals Divisions, CIM and SME, at the Chateau Laurier, Ottawa, Canada, October 2 and 3. The meeting has been planned to coincide with the region's colorful autumn, thus adding the bonus of a vacation cum business. The brilliantly clad Gatineau Hills should provide ample subject matter for the camera buffs.

The registration desk will be open at 1:00 pm Sunday, October 1, and information will be available then to help you plan your field trips. A program is being prepared for Sunday evening.

By the time you read this, the technical program will have been completed and information on it will appear in a forthcoming issue along with a sketch map showing the various routes to Ottawa and to locations available for post-meeting tours.

A kit including brochures, maps, field trip data, and details of the technical program has been prepared, but—because of the difficulty of obtaining a mailing list of interested members—we appeal to those who are interested in attending this meeting to request this kit by writing to:

J. E. Reeves, Secretary
Joint Meeting Committee
c/o 40 Lydia Street
Ottawa, Canada

Transportation Problems

That operating problems are always of interest was demonstrated at St. Louis in the well-attended Transportation of Bulky Materials Session. The papers were of a highly practical nature. They told of problems that had been faced and mastered, as well as those yet to be solved. Railroad rates, discussed by W. A. Riggs, excited spirited discussion, as did descriptions of hauling problems in Canada (see MINING ENGINEERING, May, 1961, page 462), by Amil Dubnie and N. Gritzuk; fertilizer haulage, by O. Wilhelmy, Jr.; and belt haulage by Thomas P. Douglas. The final paper on packaging, by Alfred Roetzer, looked somewhat into the future with automated bag filling and palletizing.

With the terrific competition that exists among the three major methods of bulk transportation (rail, highway, and water), the subject will always be topical and usually new.

STOP... and consider the important cost, safety and speed advantages of **NATIONAL** vertical load suspension devices.

National offers a family of specially engineered load suspension devices that are now being used successfully in new car designs ① narrow gage cars ② narrow body cars ③ and granby cars ④ These designs are fully proven, fully adaptable for use in new rolling stock or for use in equipment upgrading programs. Correct vertical load suspension extends equipment life, minimizes spillage, provides greater personnel safety, and speeds your operations.

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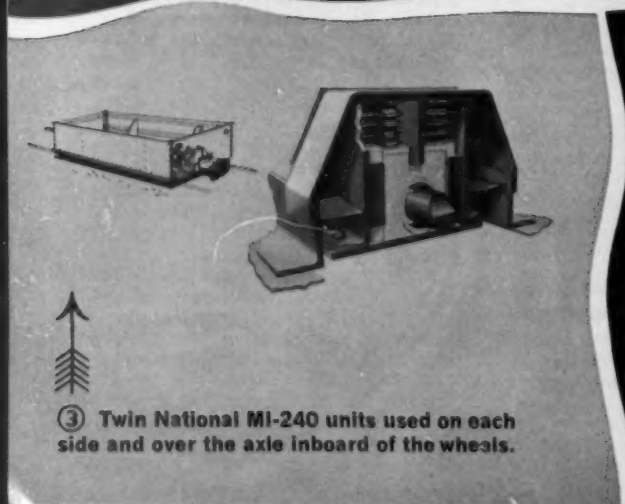
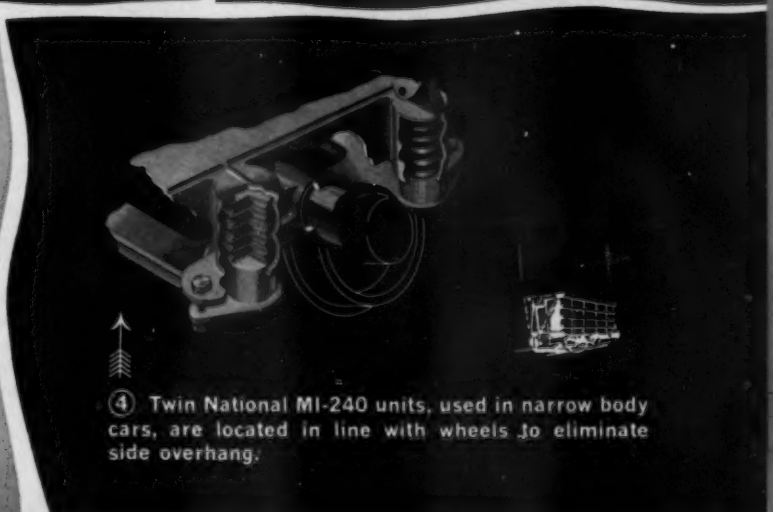
② Twin National MI-235 units used on each side of the axle center line and outboard of the wheels.



③ Twin National MI-240 units used on each side and over the axle inboard of the wheels.



④ Twin National MI-240 units, used in narrow body cars, are located in line with wheels to eliminate side overhang.

ROCK IN THE BOX

Mining & Exploration Division

Las Vegas—what fun! Seriously, your editor has just returned from the Southwest Mineral Industry Conference and Industrial Minerals Division Meeting of SME. The Nevada Section of AIME did an outstanding job of putting together a fine program. Governor Sawyer of Nevada and our AIME President R.R. McNaughton, both gave excellent luncheon addresses. All of the sessions were interesting and covered a variety of absorbing subjects.

It is always amazing to us that a serious conference can be held in Las Vegas. But, in spite of—or because of—certain distractions, miners seem to be capable of concentrating on an extraordinary diversity of problems.

Nominations and the Election

Summer is upon us and it is time to get set for fall and elections. The M&E representatives on the SME Nominating Committee and the alternates are listed below.

Representatives:

B. Dellinger
National Lead Co., Tahawus, N.Y.

L. R. Wood
Molybdenum Corp. of America, Nipton, Calif.

A. E. Weissenborn
USGS, 157 Howard Street, Spokane 4, Wash.

A. P. Morris
Kennecott Copper Corp., Ray Mines Div., Hayden, Ariz.

Alternates:

C. O. Dale
Eagle Picher, Miami, Okla.

H. A. Palmer
Wisconsin Institute of Technology, Platteville, Wis.

W. E. Heinrichs
Heinrichs Geoexploration Co., 808 W. Grant, Tuscon, Ariz.

R. Farmin
Day Mines Inc., P.O. Box 1010, Wallace, Idaho

The men of this group have a wide distribution of interests and are scattered geographically over the U.S. Even more to the point, they have all proven their interest in AIME.

Some time ago we had planned a series of articles on the workings of the M & E Division and how it fits into SME and finally AIME. Like so many good intentions, the project bogged down amidst company budgets, forecasts, capital expenditure plans, and plain paper work. The portion concerning nominations might well be brought to light at this point.

The M & E Division now consists of six units: underground mining, open pit mining, geochemical, geophysics, geology, and geological engineering. Each of the unit committees has a chairman and members who take care of publications, programs, and membership.

The M & E Division itself has officers consisting of a chairman, and a secretary. All this has been carefully outlined in a recently published organizational chart. The Division bylaws, published in the January Rock in the Box, call for a Nominating Committee of eight including the immediate past chairman, the past unit committee chairmen, and two others selected by the chairman of the Division. This group receives suggestions, nominates the officers of the M & E Division, and appoints two nominees for the post of SME director.

As stated, the M & E Division is one of four divisions in SME. (The others are: Minerals Beneficiation, Industrial Minerals, and Coal.) SME also has a Nominating Committee. This committee is made up of "two representatives from each division, with the exception of the Mining and Exploration Division which shall have four. The president and past president shall also serve. . . ."

It is the M & E Division representatives of this group who are named above. They will help select the nominees for the various offices in the Society of Mining Engineers and, at times, a candidate for President of AIME. It is an important job and certainly they deserve your help and thoughts.

Going further into the business of elections, the SME bylaws provide that "names and biographies of the nominees shall be published in the July issue of MINING ENGINEERING. Any 25 members of the Society may submit additional nominations to the Board of Directors for one or more of the positions specified." These nominations must be submitted by September 1st, and a notice will be published in the October issue of MINING ENGINEERING. If no additional nominations are received, the nominees selected by the committee are elected. Otherwise, ballots must be mailed to the voting members of the Society.

Thus SME elects its officers and aids in the election of the AIME officers. To some, this system may seem somewhat summary and committee-dictated. The problem of choosing officers in an expeditious and sensible fashion in such a large and scattered society is a hard one. By and large, the solution currently in effect seems equitable. A provision is made to allow others than those proposed by the Nominating Committee to appear on the slate, but it must be a serious nomination, backed by 25 members.

Saunders Award Committee

Under the rules set up for the Award, a standing committee makes recommendations of candidates to the AIME Board of Directors for nomination. Members of the committee are appointed for a four-year term on a rotating basis. The four new members appointed to serve, beginning this year, are: John B. Knaebel, Francis Cameron, James K. Richardson, and Clark L. Wilson.

The other members of the committee, serving under the chairmanship of Roger V. Pierce are: Warren E. Fenzi, Russell Haworth, J. B. Haffner, A. H. Shoemaker, John Payne, Jr., Gloyd M. Wiles, Robert H. Ramsey, Z. W. Bartlett, A. B. Cummins, Ian Campbell, and A. P. Morris.

The Award was established in 1927 by a gift from William Lawrence Saunders, a former President of AIME, for the purpose of recognizing distinguished achievement in mining other than coal. The term *mining* includes the production of metals and nonmetallic minerals.

M&E DIVISION NEWS EDITOR
Peter B. Nalle
Riverside Cement Co.
Box 832
Riverside, California

◄ Circle the following numbers on the reader service card:
36, MI-245 units; 37, MI-235 units; 38, MI-240 units.

International Touch at Rock Mechanics Meet

Nearly 200 people converged on the campus of the Pennsylvania State University at University Park to take part in the Fourth Annual Rock Mechanics Symposium held March 30 through April 1. The symposium is sponsored jointly by the Departments of Mining at Colorado School of Mines, University of Minnesota, Missouri School of Mines, and Pennsylvania State University. This year, through the cooperation of the National Science Foundation, it was possible to add an international touch to the meeting with the presentation of papers by scientists from France, England, and India.

Starting with the opening remarks, presented by E. F. Osborn, vice president for research, Pennsylvania State University, and concluding with a general summation by Howard L. Hartman, head of the mining department, Pennsylvania State University, the symposium included 24 papers. Subjects covered during the three-day session included Strata Movement from Underground Openings, Behavior of Rock Under Static and Dynamic Loading, Stress Measurement and Ground Control, and Dynamic Loading in Rock Penetration. Particularly significant was the progress made towards developing a valid theory of rock behavior and failure under static loading. Although more controversial, some insights into dynamic rock properties also emerged. Probably for the first time the mechanics of subsidence became understandable and workable to an American audience, and some order emerge from the wide variety of underground instrumentation techniques being developed.

In addition to the technical sessions, there were informal discussion periods, a laboratory open house, and a model blasting demonstration. Proceedings of the symposium will be published as Bulletin 76 of the Mineral Industries Experiment Station at Pennsylvania State University and will be available after August 1 for $3.00 per copy.

Duluth Plays Host to Mine Safety Conference

For the 37th year The Lake Superior Mines Safety Council held its annual spring conference on mine safety. The two-day meeting, May 25 and 26 was held at the Hotel Duluth, in Duluth. Three technical sessions were held covering such topics as: *Management's Viewpoint of Safety* by R. J. Linney, *Review of Disabling Injuries in the Lake Superior District—1960* by R. F. Wilson, *Principal Causes of Industrial Fires* by John S. Chapman, *Practical Aspects of Mine Ventilation* by G. R. Yourt, and *Hard Hats—Top Notch Protection* by L. J. Zaverl.

Social functions included luncheon on Thursday, the 25th, and a banquet that evening. Val Bjornson, State Treasurer acted as toastmaster, and Edmund H. Harding (Tarheel humorist) was speaker.

Ankeny Remains Head of Bureau of Mines

Marling J. Ankeny will continue as director of the Bureau of Mines, according to a recent announcement by Secretary of the Interior Stewart L. Udall. In a letter to Mr. Ankeny, Secretary Udall said that the Bureau is a very important part of the Department of the Interior and that he wants it to continue to be a strong and effective organization. He then continued, "In view of your outstanding qualifications and past devoted leadership, I should like you to continue as Director of the Bureau of Mines . . . ."

Mr. Ankeny has been associated with the Department for 28 years and has been Director of the Bureau of Mines since 1956.

Mine Rescue Contest Scheduled for Fall

The 1961 National First Aid and Mine Rescue Contest to be held October 2, 3, and 4 has been moved from Pittsburgh (due to uncertainty in the construction schedule of the new auditorium there) to the new Civic Center in Charleston, W. Va. The contest, sponsored by the U.S. Bureau of Mines and the Joseph A. Holmes Safety Assn. in cooperation with the National Coal Assn., the United Mine Workers of America, mining departments of certain states, and national and local coal operators' groups, is conducted regularly at two-year intervals. Copies of the operating rules for the 1961 contest are still available at Bureau of Mines Health and Safety Offices.

Froth Flotation

(Continued from page 616)

Wednesday, September 20—2 to 5 pm

Technical Session VI

Preparation of Ores and Minerals for Flotation
Brown Palace West

Hydroclones at Cerro de Pasco Concentrating Operations by *J. C. Mitton*, Cerro de Pasco Corp.

Preparation of Climax Molybdenite Ores for Flotation by *R. Cuthbertson*, American Metal Climax Inc.

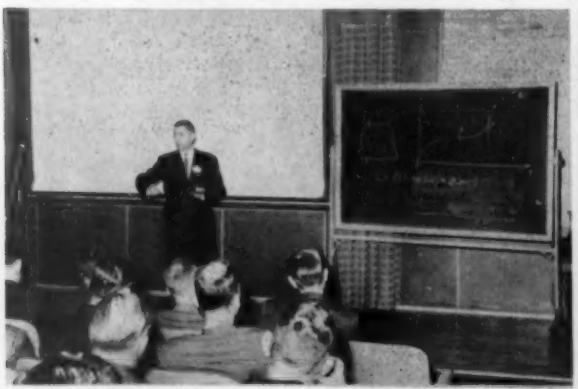
Attritioning and Conditioning in Flotation of Spodumene Ore by *N. Arbiter*, Columbia University.

The Leach-Precipitation Flotation Method of Concentration at Miami Copper Co. by *J. J. Bean*, Miami Copper Co.

Preparation of Nickel Ores and Synthetic Ores for Flotation by *International Nickel staff*.

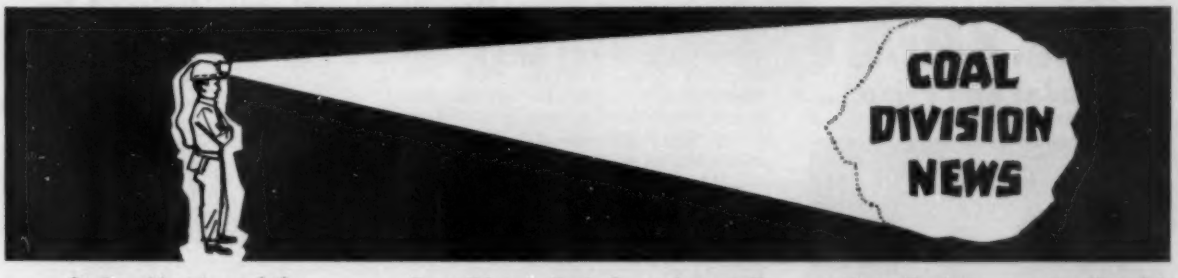
Ladies attending the meeting are invited to all technical sessions, cocktail parties, luncheons, banquets, and the Scotch Breakfast. In addition, a special scenic tour of the mountain area around Denver by bus and a luncheon are planned for Tuesday, September 19.

Two post-convention excursions are planned. One, Denver to Climax is an inspection of the by-products plant of Climax Molybdenum Div., American Metals Climax. (Not recommended for ladies). The other, Denver to Golden includes a visit to Coors Brewery, the Colorado School of Mines, and Colorado School of Mines Research Foundation.



Bertrand Schwartz, Nancy, France, emphasizes a point during the presentation of his paper to begin the initial session.

Open House at the Rock Mechanic's Laboratory which drew a large number of visitors proved to be a high point of the meeting.



Spring Meeting of the West Virginia Coal Mining Institute

Approximately 150 coal men attended the two-day meeting of the West Virginia Coal Mining Institute at Mont Chateau Lodge on Cheat Lake in Morgantown, April 21 and 22. Three technical sessions were held in the course of the meeting. The first, on Friday morning, dealt with continuous miner operations during which three papers were presented. In the afternoon the subject of the continuous miner was taken up again in two more papers. The other two papers given at this session concerned cyclone cleaning. The session on Saturday morning considered a number of topics: bulk handling of rock dust, flame resistant hydraulic fluids, the effect of using oil-water emulsions in hydraulic equipment, and fire resistant fluids.

Guest speaker at the luncheon on Friday was William F. Saalbach, Consolidated Coal Co., whose talk was entitled *Bituminous Coal Markets—1965, 1970, 1975.*

Friday evening began with a reception in the Assembly Room and was followed by an informal dinner. Both events were open to the ladies in attendance. Stephen Canonico, President of the West Virginia Coal Mining Institute presided at the dinner at which William N. Boaz, Jr., USAF, Industrial College of the Armed Forces, was guest speaker. His subject was *Public Opinion.*

An annual feature of the occasion was the presentation of The Old Timers Club Award to an outstanding senior of mining engineering from the University of West Virginia.

Wives who attended didn't lack for activities either. There were tours to points of interest in the area and a luncheon and bridge on Friday at the Lakeview Country Club.

Evansville Meeting

The Illinois Society of Coal Preparation Engineers and Chemists hosted a joint meeting in conjunction with Indiana and West Kentucky coal preparation societies on Friday, April 21 at Hillie's Restaurant in Evansville, Ind. About 75 people attended the meeting which began with pre-dinner cocktails, followed by dinner and the program. Robert E. Lee Hall, general counsel of Bituminous Coal Research and National Coal Association, was the guest speaker.

Midwestern Coal Division Subsection

About 50 people attended the April 20th meeting of the new Coal Division Subsection held at the Benton Illinois Country Club. For details see report in MINING ENGINEERING, May 1961, Around the Sections p. 509.

Coal Division News Editor

RAYMOND E. DAWSON

RESERVES

Table 2. Coal reserves of the United States, January 1, 1959, by States[1]

(In Million Short Tons)

State	Estimated Original Reserves					Reserves Depleted to January 1, 1959		Remaining Reserves, Jan. 1, 1959	Recoverable Reserves Jan. 1, 1959, 50-percent Recovery
	Bituminous Coal	Subbituminous Coal	Lignite	Anthracite and Semianthracite	Total	Cumulative Production	Production Plus Loss in Mining		
Alabama	67,570	—	—	—	67,570	834	1,868	65,702	32,815
Arkansas	1,396	—	90	230	1,716	99	198	1,518	759
COLORADO	63,203	18,492	—	90	81,785	803	1,006	80,779	40,389
GEORGIA	100	—	—	—	100	12	24	76	38
ILLINOIS	137,321	—	—	—	137,321	429	658	136,663	68,232
INDIANA	37,293	—	—	—	37,293	1,132	2,264	35,029	17,514
Iowa	29,160	—	—	—	29,160	356	712	28,448	14,224
KANSAS	20,774	—	—	—	20,774	12	24	20,750	10,375
KENTUCKY	72,318	—	—	—	72,318	2,579	5,158	67,160	33,580
MARYLAND	1,200	—	—	—	1,200	5	10	1,190	595
MICHIGAN	297	—	—	—	297	46	92	205	103
Missouri	79,362	—	—	—	79,362	285	570	78,792	39,396
MONTANA	2,363	132,151	87,533	—	222,407	170	340	221,767	119,853
NEW MEXICO	10,948	50,801	—	6	61,755	125	250	61,505	30,753
NORTH CAROLINA	112	—	—	—	112	1	2	110	55
NORTH DAKOTA	—	—	350,910	—	350,910	94	188	350,722	175,361
OHIO	43,844	—	—	—	43,844	2,018	4,036	39,808	19,904
OKLAHOMA	3,673	—	—	—	3,673	178	356	3,317	1,658
PENNSYLVANIA	75,093	—	—	22,805	97,898	13,418	26,836	71,062	35,801
SOUTH DAKOTA	—	—	2,033	—	2,033	1	2	2,031	1,016
Tennessee	25,665	—	—	—	25,665	383	766	24,899	12,449
Texas	8,000	—	7,070	—	15,070	93	186	14,884	7,442
Utah	88,184	5,156	—	—	93,340	254	508	92,832	46,416
VIRGINIA	11,896	—	—	355	12,051	754	1,508	10,543	5,272
Washington	11,413	52,442	—	23	63,878	148	296	63,582	31,791
WEST VIRGINIA	116,618	—	—	—	116,618	6,248	12,496	104,122	52,061
WYOMING	13,235	108,319	—	—	121,554	400	800	120,754	60,377
Other States	780	15,180	50	—	16,010	9	18	15,992	7,996
Total (except Alaska)	921,618	382,541	447,686	23,509	1,775,354	30,686	61,372	1,713,982	856,991
ALASKA	23,800	82,594	—	1,000	107,394	12	24	107,370	53,685
Total (including Alaska)	945,418	465,135	447,686	24,509	1,882,748	30,698	61,396	1,821,352	910,676

[1] Averitt, Paul, Berryhill, Louise R., and Taylor, Dorothy A., Coal Resources of the United States: Geol. Survey Circ. 293, 1954, p. 8. (Revised by new original reserve estimates for Colorado, Kentucky, Ohio, Oklahoma, Oregon, and Texas lignite, and with production and recoverable reserve data updated from 1952 on the basis of Bureau of Mines production figures for the period 1953-1958. Estimates for States printed in capital letters may exclude portions of the State where adequate information is lacking. Detailed footnotes appear in Circ. 293.)

Jesse C. Johnson Receives Monell Medal and Prize

JESSE CHARLES JOHNSON

Jesse Charles Johnson, director, Division of Raw Materials, AEC, was awarded the Ambrose Monell Medal and Prize at a dinner held in the rotunda of Columbia University's Low Memorial Library on Friday night, May 12. The awards were presented by Edmund C. Monell, son of Ambrose Monell in whose memory the awards were established. Mr. Johnson is the third recipient of the gold medal—the award was established in 1954—and the first person to receive the Ambrose Monell Prize of $25,000. The award, given for distinguished achievement in mineral technology, was established this year by the Ambrose Monell Foundation.

Mr. Johnson was born in Clallam, Washington and received his B.S. degree from the University of Washington, where he majored in mining engineering and geology.

He practiced as a consulting mining engineer in Seattle for a number of years, and since 1942 he has been in government service, first as an engineer, then chief engineer and deputy director in charge of domestic and foreign metal procurement with the Teconstruction Finance Corp.

In 1948 he joined the U.S. Atomic Energy Commission as deputy director of the Division of Raw Materials, and became director of the division in 1950. He has received many honors, including the distinguished service award of the Atomic Energy Commission, and the chemical engineering award of the American Institute of Chemical Engineers.

As manager of the Raw Materials Operations Office and Director of the Division of Raw Materials, Mr. Johnson was charged with full responsibility for procuring the much needed uranium required to meet the expansion of the AEC's fissionable materials production facilities for national defense. These expansions were undertaken at a time when uranium was an extremely scarce commodity and the U.S. atomic weapons capability was more or less dependent on one source, namely uranium from the Belgian Congo, from which we received approximately 90 pct of the total uranium obtained. Mr. Johnson's service in this phase of the Atomic Energy Program has resulted in our not only obtaining all the uranium required, but in becoming ourselves the leading producer of uranium in the world.

During his career Mr. Johnson has been adviser to the U.S. delegation, International Tin Conference, 1946; adviser to the U.S. delegation, International Conferences for Peaceful Uses of Atomic Energy, Geneva, in 1955 and 1958, and chairman of the International Conferences on Uranium Resources and Possibilities in Buenos Aires in 1960.

Previous recipients of the Ambrose Monell Medal are Lloyd M. Pidgeon, who made possible the economic production of magnesium metal, and Edgar C. Dain, for the development of steel alloys.

Mr. Johnson presented the principal address of the evening, at the award banquet which was attended by representatives of government, education, mining engineering societies, and the faculty and alumni of the School of Mines of Columbia University.

Zinner Honored By Interior Department

On April 19, Paul Zinner was presented the Distinguished Service Award, the highest honor the Department of the Interior can grant to its employees, in recognition of his singular contributions to the work of the Bureau of Mines. The Citation accompanying the Award reads in part:

"Coming to the Bureau of Mines at the inception of the Strategic Minerals Program in 1939, Mr. Zinner immediately displayed outstanding capabilities for organizing and directing Bureau of Mines' programs. During the next ten years he advanced to Chief of the Minneapolis Branch of the Mining Division, with the responsibility for directing exploration and development for strategic and critical mineral deposits, beginning with a crash program to bolster supplies of materials for the metal-hungry industries of World War II. . . . He became Chief of the Division of Minerals in the Washington office in 1951, and developed the present Bureau of Mines' concept for programming. The commodity program statements, prepared under his direction, were published and became a standard reference work for metals, minerals, and fuels. Since 1955 Mr. Zinner has held the position of Assistant Director—Programs, where he has achieved major improvements in the presentation and structure of the Bureau's budget and developed programs for all phases of the Bureau's work . . . His judgment has been outstanding in balancing the Bureau's efforts among the diverse areas in which it operates. . . ."

Paul Zinner, left, receives the felicitations of John M. Kelly, assistant secretary, Dept. of Interior, after the presentation of the Department's Distinguished Service Award.

REPORT FROM LAS VEGAS

Las Vegas, the glamour spot of the West, was recently the scene of a down-to-earth, highly successful technical conference sponsored by the SME Industrial Minerals Division and the Nevada Section of AIME. Also participating in the 1961 Southwest Mineral Industry Conference were the Southern California Section, AIME; San Francisco Section, AIME; and Southern California AIME Metals Branch. Under the banner *Metals and Minerals Products Meet the Challenge*, the meeting got off to a flying start in the Crown Room of the Stardust Hotel on Monday morning, April 24th. Presiding at this meeting was Victor Howard, who was the general chairman of this year's conference.

Louis Fussel, Jr., Edgerton, Germeshausen & Greer Inc., delivered the keynote address for the meeting. In the course of his talk, *Science and Technology in the Future*, Dr. Fussel discussed some of the grave implications of the explosive scientific age in which we live. He pointed out that in the last few years the disparity between scientific progress and the resolution of the social issues which it has evoked, has become tremendous. The scientist has a heavy responsibility to discuss his work and its social consequences as man must learn to adapt himself as never before to rapid changes in his environment and in his mode of life.

The other two papers presented at this session dealt with more specific problems. *The Use of Abandoned Mines for Industrial Installations* was the subject of Wm. H. Crutchfield Jr.'s illustrated talk which demonstrated how a large worked-out portion of a still-active limestone mine was converted to a refrigerated warehouse. G. Henry Ladendorff, who is a partner in the law firm of Robinette & Ladendorff, presented a paper entitled *Enlarging Pre-Discovery Possessory Rights of Mineral Locators*, which contained proposed legislation for laws governing the locating and discovery of claims.

Following this session, the all-participants luncheon was held at the Cafe Continental where the group heard a welcoming address by the Honorable Grant Sawyer, Governor of Nev.

In the afternoon four technical sessions where held: an industrial minerals session, an extractive metallurgical session, a nuclear session, and a geology session. Highlights of these sessions included a paper on *Limestone Resources of Southern California* by Cliffton H. Gray, Jr., in which he pointed out that although the resources of that area are vast, at present the use of only those deposits within a 100-mile radius of the Los Angeles market area have been developed. Another paper was offered by Stanley H. Cohlmeyer, Ronald C. Morgan, and A. S. Henderson which described the steel plant under construction at Atlantic City, Wyo. (See MINING ENGINEERING May, 1961, p. 492). Featured at the nuclear session was a paper by Milo D. Nordyke entitled *Methods of Nuclear Excavation* which described the series of experiments being carried on as a part of the Plowshare Program. A paper on natural zeolite, including means of assaying it and its potential uses, presented by Richard H. Olson headed the geology session.

In the evening everyone attended the complimentary cocktail party in the International Room of the Stardust Hotel, then went on to the dinner show at the Cafe Continental.

Tuesday began bright and early with the Industrial Minerals breakfast at which Carl F. Clausen, Division Chairman, acted as Master of Ceremonies and Lester Hartzell presented a technical lecture.

Following breakfast there were three technical sessions. The Industrial Minerals Session included surveys of the development of industrial minerals in the central and southern Rocky Mountains Region, and in Alaska, as well as papers on brucite-magnesite developments at Gabbs, Nev. and geothermal power in California. An especially interesting paper presented at the Geology Session was one entitled *Sonar Techniques for Prospecting Beneath the Ocean Bottom* by Gary Hayward, Samuel O. Raymond, and Harold E. Edgerton. The Nuclear Session presented four papers on the various aspects of the use of nuclear energy in industry.

Tuesday's all-participants luncheon featured a talk by AIME President R. R. McNaughton. Three more technical sessions were held in the afternoon, one on industrial minerals, one on physical metallurgy, and one on mining. The mining session included a paper on the development of an underground iron mine from an open pit that had reached its economic limits; one on skip haulage at Kennecott's Nevada Mines Div.; another described the benefits derived from changeover to trackless equipment in a flat-lying ore deposit; a fourth discussed the factors to be considered in the development of a mine; and the final paper dealt with input and output characteristics of electric blasting caps.

Among those attending the luncheon April 24 seated from left to right: F. Lohse, C. F. Clausen, R. R. McNaughton, V. Howard, W. L. Flangas, F. E. Love. Standing: D. C. Johnson, W. I. Watson, E. D. Dilling, C. J. Hicks, E. O. Kirkendall, W. H. Crutchfield, Jr., L. A. Wright, K. W. Mote, E. F. Lawrence, J. C. Fox. Apologies to the gentleman standing at the far right whose name we missed.

Around the Sections

• The Annual Spring Technical Session of the **Upper Peninsula Section** was held April 22 in the Civil-Geology Building on the Michigan College of Mining and Technology campus. The program was concerned with the agglomeration of low grade iron ores. Four papers were presented during the morning session with a coffee break after the first two. At the end of the session there was a social hour at Douglas House, followed by a luncheon. The technical session began with a student panel discussion of *Underground Automation and Mechanization*. Alan Broderick, Inland Steel Co., presented a paper entitled *Geologic History of Iron-Formation and Its Bearing on Beneficiation Characteristics;* Kenneth C. Olson, Humboldt Mine, discussed *The Operation of a Grate-Kiln Pelletizing Plant*, and *A Progress Report on the Effect of Grind, Temperature and Pellet Size Upon the Quality of Specular Hematite Pellets* was offered by Daniel M. Urich and Tsu-Ming Han, The Cleveland-Cliffs Iron Co.

• **The Hudson-Mohawk Section** met at the Carriage House in Latham, N.Y., on April 20 where they heard Karl Aust of General Electric Research Laboratory discuss *Grain Boundary Mobility—A Review*.

• The April 7 meeting of the **East Tennessee Section** featured an address by Richard A. Young, vice president of American Zinc, Lead & Smelting Co., who had just returned from Europe where he had been a member of the U.N. Lead-Zinc Study Group. The meeting began with a stag dinner at the Holiday Inn in Knoxville, Tenn.

Richard A. Young, left, speaker at the East Tennessee Section meeting in April with Joseph A. Miller, section chairman.

• A joint meeting of the **El Paso** Section and **Kidd Mining Club** was held on the campus of Texas Western College, April 20. About 70 people heard nine senior students give reports on research in metallurgy. Earl Donahue, who recently retired as works manager of Phelps-Dodge Refining Corp.'s copper refinery at El Paso, was awarded life membership in the El Paso Section.

The Section held its spring dinner dance on May 20 at the Paso del Norte Hotel in El Paso.

• The **St. Louis Section** held its Ladies Night meeting at Ruggeri's Restaurant on May 12.

• More than 125 people attended the April 12 meeting of the **Tucson Subsection** (Arizona Section) at the Cliff Manor Motor Hotel, where they enjoyed a roast chicken dinner. The evening's program consisted of three illustrated talks on the San Manuel operations by members of the San Manuel Copper Corp. staff. Lloyd Thomas, chief geologist, discussed the geology of the San Manuel deposit; J. D. Pelletier, planning engineer, described the subsidence at San Manuel; and Charles Pillar, mine superintendent, discussed the effect of rock formations on the mining practices. There were numerous questions about the operation following the talks.

• Members of the **Maricopa Subsection** (Arizona Section) heard a talk entitled *Water in Arizona* by Rich Johnson, president of the Central Arizona Project Assn., at their meeting April 6 held in the Arizona Ranch House Inn.

The Inn was also the scene of the Section's annual Ladies Night meeting on May 4. A specially prepared movie of the South Seas by Chuck Heflin entitled *Adventures in Paradise* was the evening's feature.

• The **Ajo Subsection** (Arizona Section) held its monthly meeting March 14 at the Copper Coffee Shop. Bert Coleman, assistant director, Arizona Development Board, gave a summarization of the Board's work.

On April 13 the Section held a steak fry at the Ajo Country Club for high school students interested in the mining industry. Dean Chapman and Dean Forrester of the University of Arizona School of Mines spoke to the students.

Officers for the year beginning October 1 were elected as follows: E. T. Seaberg—chairman, J. M. Sudler—vice chairman, and J. E. O'Neill —Secretary-Treasurer.

• About 100 members and guests of the **San Francisco Section** turned out at the Engineer's Club on April 22 to hear Kirk Carlton, Mining Div., Link Belt Co., discuss *Mining with the Bucket Wheel Excavator*.

• The **Uranium Section** met April 4 at the M-4 Ranch House in Moab where members saw a film titled *Mechanized Mining Equipment* which was presented by Burt E. Hartmann of Teknico.

On April 27 the Section met with Ronald R. McNaughton, E. O. Kirkendall, and Clifford J. Hicks, respectively President, Secretary, and Western Field Secretary of AIME.

• The **Mexico Section** met at the University Club on April 10 where 25 people gathered for dinner and the subsequent program. Enrique Madero Sr., president of the Section, presided. Lloyd Staples, director of the School of Geology, Oregon University of E.U.A., gave a talk on the mineralogy, and metallurgy of mercury, and answered questions from the audience at the end of his talk.

• Members of the **Washington D.C. Section** held their monthly dinner meeting at the Broadmoor Apartment Hotel on April 4th. Thomas P. Thayer, chromite commodity geologist with USGS, discussed *Some Glimpses of the Free World Chromite Situation—Present and Future*. He illustrated his talk with color slides of the principal chromite deposits of the world, including those in the Philippines and Turkey.

• Members and their wives had a full schedule at the April 15 meeting of the **Central New Mexico Section** at Socorro. In the afternoon there was a choice of field trips and sports. Earl Elstone conducted a tour through the Hansonburg Mining District. There were also tours of the Great Lakes Carbon, Perlite Plant and New Mexico Inst. of Mining and Technology,

which included the New Mexico Bureau of Mines Laboratories and Plant. Arrangements were made for golf, swimming, and tennis for those interested. The Socorro WAAIME's played hostess at an afternoon of coffee and cards for the women not interested in the field trips or sports.

In the evening a dinner was served at the college dining hall. Following the business meeting, members and their wives were treated to a motion picture about thunder storms. Paige Christiansen was principal speaker of the evening—his subject being, *Southwest Mining Adventure in Historical Research.*

• About 50 people heard A. Allan Bates discuss *American and Soviet Uses of Engineering Materials* at the April 5 meeting of the **Chicago Section** held at the Chicago Bar Association. Dr. Bates, vice president of the Portland Cement Assn. and president of the American Society for Testing Materials, illustrated his talk with color slides. It was based on a trip through Russia and Siberia in the summer of 1960, which he made as head of a delegation of American construction experts. He pointed out how progress and civilization are associated with urbanization and industrialization, and used the European Renaissance Period as an illustration. Revolutionary Russia has not had time to go through a renaissance of several hundred years; in 1885, 15 pct of the country was urban and 85 pct rural, whereas in 1960 the figures were 52 pct and 48 pct respectively. The success of the present regime depends on industrialization and urbanization which again means construction. Construction in Russia means concrete! Providing, in a short time, new apartments for 100 million people, the Soviet makes extended use of precast, prestressed, prefabricated, and highly standardized elements. Actual construction, therefore, is largely an assembly job and more than 2000 factories are engaged in manufacturing industrial buildings and apartment houses either as building elements or entire two or three room apartments. This entire construction program follows rigid masterplans developed by the central government based on research. Following the talk there was heated discussion on technical and sociological aspects associated with this enormous construction program.

Other items on the agenda were a review of the results of the new type meetings that have been tried to provide programs of interest to both metallurgical and mining men by Frank Hunter of the Program Committee and the presentation of an SME membership award to W. C. McCulloch.

• **The Montana Section** and the Montana Society of Engineers held their annual joint meeting Saturday evening, March 25 at the Montana Hotel in Anaconda. An excellent prime rib dinner followed a social hour hosted by The Anaconda Co. During the business meeting which followed, the membership was brought up to date on the latest developments in the dispute between the State Highway employees and the State Highway Commission. Speaker of the evening was Charles Holstrom who presented a paper prepared by E. D. Tierney, assistant vice president in charge of Western Operations, The Anaconda Co. The illustrated talk entitled *Metallurgical Changes in Anaconda's Operations* showed the most recent innovations used in the company's milling and smelting operations. About 110 people attended the meeting.

The Section's April meeting held on the 13th at the Montana School of Mines in Butte was open to the public because of the general interest in the main topic of the evening. David Rabb of the Plowshare Div., Lawrence Radiation Laboratory, University of California, presented an outstanding program entitled *Underground Mining Nuclear Explosives, Past Tests and Future Possibilities* (see News, page 548). His talk was supplemented with slides and two AEC films. The first film gave a vivid account of all previous underground nuclear test shots and the second one dealt chiefly with the Atomic Energy Experimental Mine using a nuclear explosive. Besides the detailed account on how nuclear devices may be utilized in mining, Mr. Rabb also illustrated other possible applications of nuclear explosives which appear to be feasible. More than 100 members and guests enjoyed this glimpse into the future.

• The **Adirondack Section** announced its officers for the 1961 season as follows: George Erdman—chairman, Patrick F. Farrell—vice chairman and program chairman, T. J. Leonard, Jr., secretary-treasurer, Howard C. Rowand—student affairs chairman, Ralph Biche—membership chairman, and Ralph L. Henry—publicity chairman.

The Section's first meeting of the new season was a tour of the National Lead Co. plant at Tahawus, N. Y., Saturday, April 29. After touring the plant, members had a chance to observe a mine blast. A symposium on ammonium nitrate blasting followed at Foote Cottage, with Walt Chapman, mine superintendent, leading the discussion. The meeting ended with cocktails and dinner.

NO MAJOR REPAIRS IN 25 YEARS*

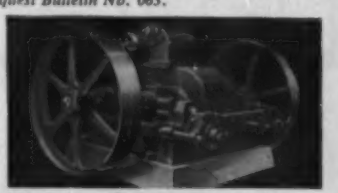
Sturtevant Construction Assures Long Mill Life at Top Loads

Sturtevant crushing and grinding machinery answers the long life top-load production problem for medium to small size plants. Many Sturtevants have been operating above rated capacities for more than 25 years, and *without a major repair.*

"Open-Door" design gives instant accessibility where needed — makes cleanouts, inspection and maintenance fast and easy. Machines may be set up in units to operate at equal quality and capacity.

Jaw Crushers — Produce coarse (5 in. largest model) to fine (⅛ in. smallest model). Eight models range from 2 x 6 in. jaw opening (lab model) to 12 x 26 in. Capacities to 30 tph. All except two smallest sizes operate on double cam principle — crush double per energy unit. *Request Bulletin No. 062.*

Rotary Fine Crusher — Reduce soft to medium hard 3 to 8 in. material down to ¼ to 1¼ in. sizes. Capacities up to 30 tph. Smallest model has 6 x 18 in. hopper opening; largest, 10 x 30 in. Non-clogging operation. Single handwheel regulates size. *Request Bulletin No. 063.*



Crushing Rolls — Reduce soft to hard 2 in. and smaller materials to from 12 to 20 mesh with minimum fines. Eight sizes, with rolls from 8 x 5 in. to 38 x 20 in.; rates to 87 tph. Three types — Balanced Rolls; Plain Balanced Rolls; Laboratory Rolls — all may be adjusted in operation. *Request Bulletin No. 065.*

Hammer Mills — Reduce to 20 mesh. Swing-Sledge Mills crush or shred medium hard material up to 70 tph. Hinged-Hammer Pulverizers crush or shred softer material at rates up to 30 tph. Four Swing-Sledge Mills with feed openings from 6 x 5 in. to 20 x 30½ in. Four Hinged-Hammer Pulverizers with feed openings from 12 x 12 in. to 12½ x 24 in. *Request Bulletin No. 084.*

*Reports Manager W. Carleton Merrill concerning Sturtevant Swing-Sledge Mill at James F. Morse Co., Boston.

STURTEVANT
MILL COMPANY
162 Clayton St., Boston 22, Mass.

Circle the following numbers on the reader service card: 39, Jaw Crushers; 52, Rotary; 53, Rolls; 54, Hammer Mills. ▲

Around the Sections

Continued

• The annual field trip of the **Ohio Valley Section,** April 21, was a tour of the Industrial Nucleonics Corp. plant in Columbus. Before the tour, members dined in the plant's dining room and heard James Rinehart, production manager, speak on the objectives and growth of Industrial Nucleonics.

• The **Arizona Section** professional divisions all held spring meetings recently. The **Mining Geology Division** was the first to meet—on April 14 at the Esperanza mine of the Duval Sulphur & Potash Co., 30 miles south of Tucson. There was a business meeting and a short technical paper on the mine before the tour of the pit. After lunch, there was a field trip through the Pima mine and Twin Buttes area. The **Open Pit Division** met at Ajo on April 24. The program opened with a preliminary orientation session on the history and geology of the area, followed by a tour of the New Cornelia open pit mine. In the afternoon there was a technical session on subjects related to the New Cornelia pit: *Blasting Practices* by E. T. Seaberg; *Primary Drilling* by W. T. Sullivan; *Repair and Maintenance of Equipment* by O. F. Fenzi; and *Pit Operations* by J. A. Littrell and A. D. Bausman. The **Smelting Division** went to southwestern New Mexico for its spring meeting which was held May 6 at Hurley. There was a tour of the smelting operations in the morning; lunch at the Murray Hotel in Silver City; and technical discussions in the afternoon covering converter practice at Chino and a description of the mist-cooled plate. There were also colored photographs of the charge piles at the Ray Smelter. The Pima Mining Co. acted as host to the **Ore Dressing Division** at its spring meeting May 13. The meeting began in Tucson where descriptions of the Pima concentrator were given, then after lunch the metallurgists were taken to the concentrator south of Tucson.

• The spring meeting of the **Pennsylvania-Anthracite Section** was held April 28 in the restaurant of the Host Motel at Wilkes-Barre, Pa. John W. Buck showed a motion picture of hydraulic mining tests of anthracite conducted by USBM, and as an added attraction, colored motion pictures of the highlights of the 1960 World Series were shown by courtesy of the Coca Cola Bottling Co.

• The **Colorado MBD Subsection** held its annual meeting May 20 at the Broadmoor Hotel in Colorado Springs. The morning was devoted to a business meeting and the afternoon to a technical session at which four papers were presented. They were: *Applications for Hi-Alumina Ceramics in Mineral Dressing* by Robert E. Lintner; *Sampling and Sample Handling for Continuous Process Control* by Clyde V. Johnson and Paul E. Cook; *New Milling Equipment* by Paul Goddard; and *New Climax Tailings Pond Design* by Frank J. Windolph. The meeting ended with a dinner-dance in the Broadmoor ballroom.

NOTE: The July issue of MINING ENGINEERING will carry the annual membership directory of the Society of Mining Engineers of AIME.

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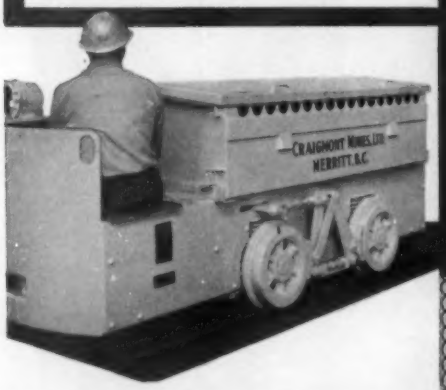

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Personals

Charles T. Holland, head of the Dept. of Mining Engineering at Virginia Polytechnic Institute, has been appointed dean of the School of Mines at West Virginia University and director of Mining and Industrial Extension. Mr. Holland will take over his new duties August 1st. He is a West Virginia alumnus and served for nine years as a member of the faculty. He left in 1948 to accept his present position at Virginia Polytechnic Institute. His new appointment fills the vacancy created by the death of **G. Ralph Spindler** in February of this year.

C. T. HOLLAND

R. A. BEALS

Rixford A. Beals, formerly editorial director of MINING ENGINEERING has been named manager of the Commercial & Industrial Div. of the National Better Heating-Cooling Council, 250 Park Avenue, New York. Mr. Beals was with AIME for nine years, as assistant and associate editor from 1952 to 1955, and editorial director from 1955 to 1961.

Jack H. How, president of Western Machinery Co., has been elected to the board of directors of Arthur G. McKee & Co. Since January of this year, Western Machinery Co. has been a wholly owned subsidiary of McKee.

According to a recent announcement from the president of the Norfolk and Western Ry, **G. A. Shoemaker,** president of Consolidation Coal Co., has been elected a director of the Railway to fill the unexpired term of the late **Robert H. Smith.** Mr. Shoemaker will also serve on the board's finance committee.

Alan A. Bakewell, Jr. has gone to Skouriotissa, Cyprus as mines superintendent for Cyprus Mines Corp. He had formerly been in Cuba with Nicaro Nickel Corp.

H. T. Heard has moved from Peru, where he was mines manager for Compania Minera Condoroma, S.A., to Bolivia to take a similar position with International Mining Co.

George A. Moerlein, who has been associated with Bear Creek Mining Co. as a geologist for the past seven years, has been sent to Anchorage to take charge of its newly established exploration office there.

Charles M. Taylor is currently finishing his work toward a Ph.D. degree in economic geology at Stanford University. Prior to returning to graduate school, he worked for Kennecott Copper Corp., Nevada Div.

J. A. THIERRY

M. H. BIRK

Bucyrus-Erie Co. recently announced the election of **John Adam Thierry** to the board of directors and the appointment of **Merlin H. Birk** as vice president. Mr. Thierry, a Bucyrus-Erie vice president, has served as secretary of the corporation since 1958 and general attorney since 1957. He is also a director, vice president, and manager of operations of Bucyrus-Erie Co. of Canada Ltd. Mr. Birk has been controller since joining the firm in 1959. Prior to that he was assistant to the president of Illinois Tool Works.

Following completion of his graduate studies at the University of Minnesota, **John H. Snyder** has taken a position as industrial engineer with International Minerals & Chemical Corp., in Carlsbad, N. M.

A. J. Oppermann, formerly project manager—cadastral mapping for Aero Service Corp., has become minerals valuation engineer, U.S. Army Corps of Engineers—Huntington, W. Va. District.

William G. Clark, formerly with the Northern Peru Mining Corp., has been appointed superintendent at the Charcas Unit of Cia. Minera Asarco.

Thorp D. Sawyer, consulting engineer, has moved his office to 1415 West Wetmore Rd., Tucson, Ariz.

Rodolfo V. de la Cruz has left his job as mining engineer with Itogon-Suyoc Mines Inc. to take a similar position with the Philippine Bureau of Mines. There he is engaged in exploration of coal deposits by diamond drilling.

Donald Macleod has been promoted from superintendent to assistant manager (metallurgical) for Rhokana Corp. Ltd., Nkana, Northern Rhodesia.

Hidemasa Kubo has left Japan, where he was manager of Nippon Mining Co. Ltd.'s Takatama mine, to operate the company's Chapi mine in Peru as manager of the Peru Branch.

W. A. O'BRIEN

L. F. BISHOP

Lester F. Bishop, chief research engineer, mining research department and **Wallace A. O'Brien,** Butte mines geologist for The Anaconda Co., retired April 1. Both are natives of Butte and graduates of the Montana School of Mines. Both have been active in the mining industry for more than 40 years, and have been associated with Anaconda operations throughout their careers. While still a student, Mr. Bishop worked part time at the Nettie mine. Mr. O'Brien also worked as a miner while attending college.

James H. Ogg, who had served as manager of the Houston Geological Dept. of Texas Gulf Sulphur Co. for the past 18 months, has been transferred to Moab, Utah as geological engineer to work on the company's new potash development.

Gordon H. Chamber, former chairman of the Board of Foote Mineral Co., was recently elected to the Board of Directors of The New Jersey Zinc Co.

Peter Joralemon, consulting geologist headquartered in San Francisco, and president of New Zealand Mines Ltd., recently made a four week tour of New Zealand to direct an exploration program for the discovery and development of new gold deposits.

After eight years of mining activity in Peru with Cerro de Pasco Corp. as assistant mine superintendent, **J. F. C. White** returned to Great Britain to go to work for Costains Mining Ltd., Scotland as chief engineer at Westfield Opencut Mine, a large coal strip mine operation.

James D. Edgerley has moved from Toronto, where he was branch manager for Mine Equipment Co. Ltd., to South San Francisco to become sales engineer for Alimak Corp.

George H. Chapman has established a consulting practice with an office in Chicago. Prior to striking out on

personals

continued

his own, he was associated with the Paul Weir Co. for 12 years and was senior engineer at the time of his resignation.

Matti S. Tavela, who had been engaged in the discovery and development of iron sand deposits in the Philippines as chief geologist for Philippine Island Mineral Exploration Inc., has returned to his home town of Kangasala, Finland to become a consulting geologist.

George T. Beardshear, formerly director of mineral development for Pittsburgh Pacific Co., is in charge of mining engineering and mine production for Tidewater Oil Co.'s Uranium Div. operations at Shirley Basin, Wyoming.

Byron S. Day, Electro-Nuclear Metals Inc., has been promoted from assistant superintendent to plant superintendent and is in charge of research and development of all rare metals and complex ores.

Fred R. Dice has gone to Grants, N. M. to take a position of junior mining engineer with Kermac Nuclear Fuels Corp. He had been a junior development engineer with Oliver Iron Mining Div.

After 18 years with The Anaconda Co., **Winton L. Seymour** has moved to Maine to become associated with Andes Exploration Co. of Maine as a geologist.

David R. Cole has joined the Colorado Bureau of Mines as senior metal mine inspector. He was formerly project engineer for Idarado Mining Co.

After more than 2½ years spent in South America as geologic advisor in an atomic energy assistance program, **John W. Gabelman** has been transferred to the Washington, D. C. office of the U.S. Atomic Energy Commission where he is serving as mining geological engineer in the Division of Raw Materials.

Theodore I. Jerman has been transferred to the Potomac River Development Laboratory of E. I. du Pont de Nemours & Co. Inc. as research engineer. He formerly worked as a salesman in the Explosives Div., in Wilmington, Del.

H. Hartjens, formerly a metallurgist with Newmont Exploration Ltd., is serving as technical representative and manager of Sucursal del Peru (Cyanamid Inter-American Corp.) with headquarters in Lima.

ROBERT BROOKS

H. FREYENSEE

Bucyrus-Erie Co. recently announced two new appointments in its sales department. **Howard Freyensee** was named general products sales manager and **Robert P. Brooks** was named to succeed him as large machine sales manager. Mr. Brooks was manager of mining machine sales prior to his new appointment.

Following a stay in England, **John W. Semmens** has gone out to the Transvaal as assistant underground manager for Messina (Transvaal) Development Co. Ltd.

David L. Francis, president of Princess Coals Inc., and NCA treasurer, was elected vice president of the U.S. Chamber of Commerce's southeastern division for a one-year term.

Following graduation from Washington State University, **Howard G. Kraus** has gone to work for the city of Arcata, Calif. as assistant city engineer designing a highway and utility relocation project for the city.

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PERSONALS: Please list below your former company and title and your new title and company (or new work) for use in MINING ENGINEERING. (Copy deadline for personals items is six weeks before date of issue.)

Former Company .....

Former Title ..... Length of Time There .....

New Company .....

New Title ..... Date of Change .....

.....

Any recent activity that would be of interest to members:

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R. H. Knode retired March 31 as head of Stonega Coke & Coal Co., The Virginia Coal & Iron Co., Westmoreland Coal Co., Westmoreland Inc., and General Coal Co. He will continue as a director and chairman of the executive committees of the companies.

S. I. Bowditch, geologist for American Smelting & Refining Co., has been transferred from the Salt Lake exploration office to the Ironton exploration office where he is handling property problems.

M. S. REFORD

P. J. BERG

Michael S. Reford has been named chief geophysicist for the Aero Service Group, a worldwide complex of integrated air survey companies. He joined Canadian Aero Service Ltd. five years ago to direct survey planning and operations, and the interpretation of airborne geophysical data. He is presently engaged in the planning and technical direction of airborne geophysical programs in Australia, Egypt, Morocco, Uganda, Chile, Canada, and the U.S.

Dravo Corp. recently appointed **Philip J. Berg** manager—sales and development for the Engineering & Construction Dept. of its Machinery Div. **J. H. Porteus** was appointed chief development engineer—ore processing, reporting to Berg. Mr. Berg has been with Dravo since 1946 and was manager of general construction sales at the time of his recent appointment. Mr. Porteus joined the company in 1951 as assistant chief design engineer of the Machinery Div., the post he held prior to his new appointment.

After 12 years with Torbrit Silver Mines Ltd., where he was mine superintendent, **H. Bapty** has become associated with H. G. Young Mines Ltd. as grade controller.

Following graduation from the University of Arizona, **H. Downey** has gone to work for Bear Creek Mining Co. as a field assistant in its Tucson office.

G. B. Kneass has been promoted from general plant superintendent to operations manager by Foote Mineral Co.

Thomas C. Whisler, Jr., a sales engineer for American Manganese Steel Div. has been transferred to Phoenix, Ariz., where he is serving as southwestern sales manager.

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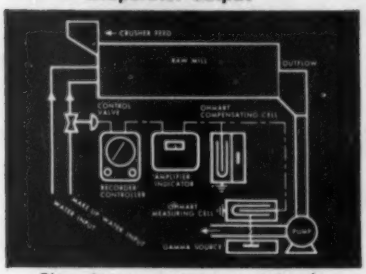

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personals

continued

Norman Archie Radford, formerly district geologist with the Idaho Department of Highways, has moved to Montana to become geologist for Trout Mining Co.

Fred R. Sargent, formerly assistant quarry superintendent at the Permanente quarry of the Permanente Cement Co., has joined the staff of *Mining World* as district manager of the Chicago office.

William Minshong Huang has moved to Blacksburg, Va. where he was associated with the Virginia Tech Station, to Jacksonville, Fla., where he is employed by Carpco Research & Engineering Inc.

Jay A. Poll has moved from Lively, Ont., Canada, where he was employed by International Nickel Co. of Canada Ltd., to Winter Haven, Fla. to take a position with International Minerals and Chemical Corp.

R. C. Howard-Goldsmith has joined the U.N. Technical Assistance Program as a mineral resources expert and has been assigned to the Niger Republic, W. Africa.

Bruce Karinen has taken a position with Hercules Powder Co., at Bacchus, Utah. He was formerly a geologist with Union Carbide Nuclear Co.

Riley S. Smith Jr., formerly a member of the department of geology at Bera College, has become director, Division of Earth Sciences, East Texas State College.

J. F. Dear resigned as assistant metallurgist at the Central Metallurgical Laboratory of the Anglo American Corp. of South Africa Ltd. to take a similar position with The Messina (Tvl) Development Co. Ltd.

After many years working in the mining fields of Brazil, **Gilbert Whitehead** is retiring this month and will take up residence in Prescott, Ariz.

Centrifugal & Mechanical Industries Inc. recently announced a number of top-level personnel changes. **Elmer O. Binder,** formerly executive vice president, has been elected chairman of the board of directors and president. **P. W. Bigley** was elected executive vice president and member of the board of directors. He was formerly vice president—sales. **James E. Bilderback,** formerly sales manager, was promoted to vice president—sales, and elected a member of the board of directors. Other appointments were that of **James C. Artrip** to direct the sales and service activities in the company's Pittsburgh office and that of **Lucian C. Morrison** to be in charge of all sales and service activities in the southeastern district.

More then 1400 ft underground, Saskatchewan's Premier **T. C. Douglas** *(right) and* **Thomas M. Ware,** *president of International Minerals & Chemical Corp. (Canada) Ltd., install the final bolt in a cast-iron shaft lining that walls off a 200-ft layer of quicksand, an engineering feat that paves the way for opening Canada's vast potash reserves to world markets. The IMC plant and mine should be operating in 15 months.*

STANTON WALKER

A. A. BATES

Among the recipients of awards made by the American Concrete Institute at its annual convention were **Stanton Walker,** National Sand & Gravel Assn. and National Ready Mixed Concrete Assn, who received the Turner Medal and **A. Allan Bates,** Portland Cement Assn., who received the Kennedy Award.

O. G. Lellep, engineering consultant to Allis-Chalmers processing machinery department, has been awarded the Carl Lueg Memorial Medal by the German Society of Iron and Steel Engineers in recognition of his pioneering work in applying oxygen to the production of steel.

Richard S. Newlin, vice president—operations of The Anaconda Co., has been appointed chairman of the Uranium Mining and Milling Committee of the Atomic Industrial Forum Inc., and **A. P. Kibbe,** president of Hidden Splendor Mining Co., was named vice chairman.

David C. Sharpstone has returned to Toronto after completing a professional engagement in Nigeria.

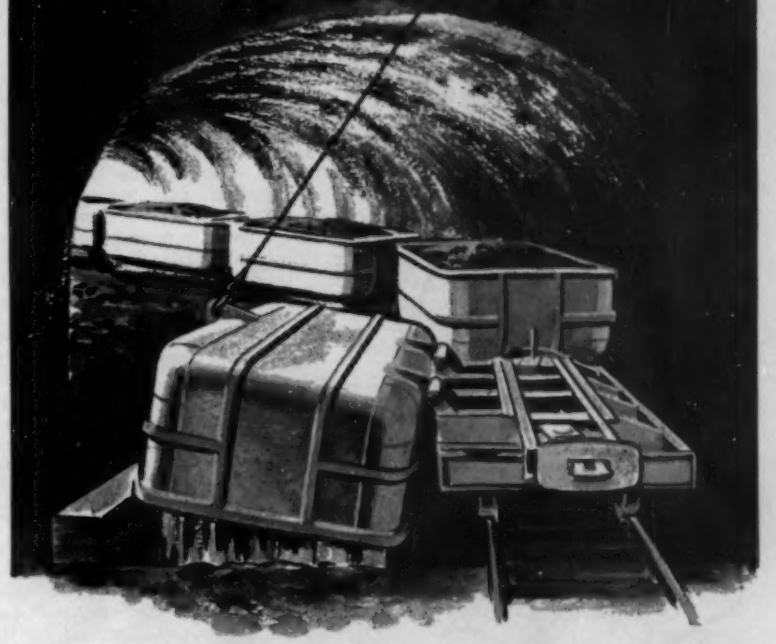
A. R. MERZ

R. H. LEWIN

Richard H. Lewin, vice president and director of Cerro Corp., has been elected president of the company's subsidiary, Cerro Sales Corp. He was formerly president of Cerro's Lewin-Mathes Div. in St. Louis, and has been a director of the parent company since 1957, and a vice president since 1959. Mr. Lewin fills the post vacated by **A. Russell Merz** who resigned for reasons of health at the end of last year. Mr. Merz will continue to serve Cerro Corp. in certain advisory and consulting capacities.

After more than 40 years of service with Allis-Chalmers, **Bert H. Puerner** retired early this year. He was manager of special projects for Allis-Chalmers International for the last three years.

KERMAC SOLVES AMBROSIO LAKE SLIMES WITH TELLURIDE TYPE CARS



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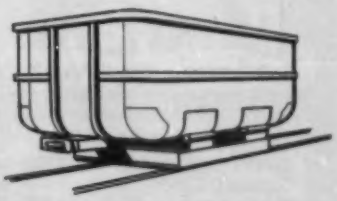
Solve your haulage with an economical Card design. Our engineers can supply an efficient car to meet your most difficult specifications.



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Reno, Nevada.....FAirview 9-0732
Spokane, Washington....WAlnut 4-2614
Alaska.....Contact Salt Lake City Office

Circle No. 46 on the reader service card.

personals

continued

Richard H. Willey, who was general manager of Nickel Processing Corp. in Micaro, Cuba at the time of its nationalization and was escorted from Micaro by the Revolutionary representatives, is presently working for Hercules Powder Co. in Bacchus, Utah, as administrative assistant to the works manager.

Paul Linz has been elected president of the newly organized Primary Metal and Mineral Corp., 120 Wall St., New York. His career has been devoted principally to exporting, importing, and trading in metals, minerals, and ores which will constitute the new company's activity.

Paul M. Hedley has become president of Udel Realty Corp., a subsidiary of New York Trap Rock, which is engaged in the lightweight aggregate business. He was formerly vice president—operations for North American Cement Corp.

The Hanna Mining Co. recently announced the appointment of **Ernest L. Ohle** as staff geologist. He was formerly vice president and chief geologist of the Copper Range Co. and White Pine Copper Co. He will make his headquarters in Cleveland.

W. Julian Parton was recently elected president of The General Crushed Stone Co. He had been vice president—operations since 1959, and prior to that served as assistant to the president and director. He has been associated with the company since 1955.

The Atlantic Coast Line RR Co. recently announced the appointment of **Charles K. Brown** as indusrial geologist.

R. J. McGINNIS

PAUL WEIR

After 16 years with Kennametal Inc. and 57 years in the coal mining industry, **Robert J. McGinnis** retired in February. He is widely known in the mining tool field for the pioneering role he played in coal mine mechanization by application of tungsten carbide tools. In his retirement he will be active in his three sons' firm, McGinnis Bros, Bit Service Inc., serving as president and treasurer.

Paul Weir, chairman of the board of Paul Weir Co. Inc., has just returned from a trip which took him to Australia, South Vietnam, India, Turkey, and Great Britain for a series of conferences on coal mining.

In a major staff reorganization of Vitro Chemical Co., **James D. Moore** has been named manager of Western Operations. In this new capacity, he will have overall management responsibility for all Western activities including manufacturing, mining, purchasing, personnel and administration. In his new position, Mr. Moore will conduct negotiations currently being carried on with the AEC Grand Junction Operation office for an extension of Vitro's contract for uranium production. Until his promotion he was plant manager.

Secretary of the Interior **Stewart L. Udall** *(kneeling, left) on his first visit to a coal mine, watches coal move on a conveyor belt from a shuttle car dumping at right in the No. 3 mine of Cannelton Coal Co.* **Paul Morton,** *company president, explains the operation. Behind him is Sen.* **Jennings Randolph.** *Gov.* **W. W. Barron** *of West Virginia is between the Secretary and Morton. At the right,* **N. G. Clonch,** *superintendent.*

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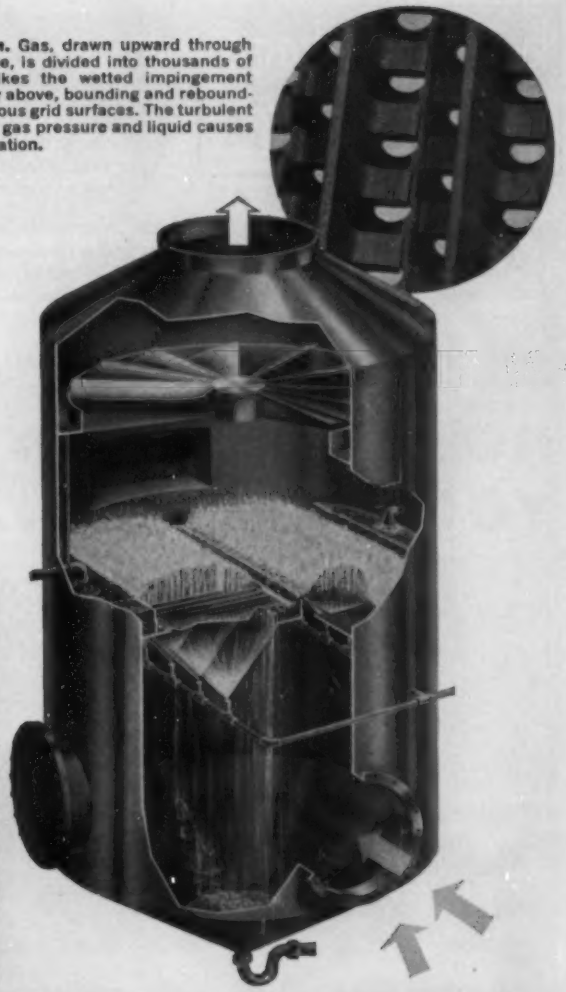

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Scholarships

Stewart L. Udall Scholarship Award

A Stewart L. Udall Scholarship Award will be established at the University of West Virginia in honor of the Secretary of the Interior's recent visit to the coal mines in the area. The announcement was made by Laurence E. Tierney, Jr., president of the West Virginia Coal Assn. at a dinner for the Secretary given by the National Coal Assn. The scholarship will be made available through the University of West Virginia to a West Virginia high school graduate interested in a mining engineering course.

Colorado School of Mines

Three Colorado high school seniors were awarded four-year scholarships to the Colorado School of Mines at the opening session of the annual Engineers Day program. The awards, valued at $1040 each, are given annually to the top three finalists in the statewide E-Day examination. This year's recipients are: Jay M. Johnson, Jack C. Smith, and William W. Everett.

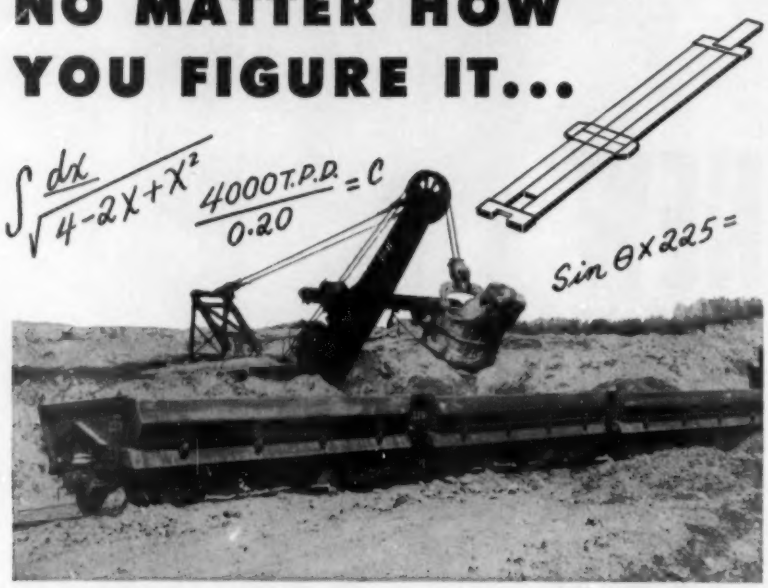
Tau Beta Pi Fellows

Of the seven young engineers selected by Tau Beta Pi for fellowship awards this year, only one, Franklin D. Coffman, Jr., was from the mining-metallurgical field. He graduates from the Colorado School of Mines in metallurgical engineering this year and plans to take graduate work in mineral technology at Carnegie Institute of Technology.

American Metal Climax Foundation Inc.

An unrestricted grant of $10,000 has been made to the Colorado School of Mines Foundation Inc., the third such gift the Foundation has made to the mineral engineering college. The money will be used in the continuing faculty improvement program which the CSM Foundation sponsors.

NO MATTER HOW YOU FIGURE IT...



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Obituaries

William Selkirk (Legion of Honor Member 1900) died Feb. 16, 1961 in his 90th year. He was born in England and received his professional training by being articled to a mining engineer. He subsequently served as manager of iron mines in England, manganese in Spain, gold in West Africa, and copper in Mexico. By 1900 he was working in California as mine superintendent for Mountain Copper Co. In later years he returned to England to establish a consulting practice in London.

R. A. Tregonong (Member 1920) succumbed to a heart attack Nov. 10, 1960. He was born in Coe Hill, Ont., Canada on March 14, 1886. He was a graduate of Michigan State College of Mines. In the early days of his career he worked in the mining areas of Michigan. In 1915 he went to South America where he remained until 1930 working for various mining companies in Chile, Colombia, and Peru. Upon his return to the U.S. he settled in Florida but in later years went back to Michigan where he died.

R. M. Atwater, Jr. (Legion of Honor Member 1897) died recently at the age of 87. His long and distinguished career in the mining profession spanned a period of nearly 65 years and six continents. He was born in Millville, N.J. and received his professional education at the Royal School of Engineering, Charlottenberg, Berlin, Germany. During his summer vacations he worked in mines in Spain, railway shops in

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Paris, and a glass factory in England. Immediately after graduation he was employed as a junior staff engineer by The Exploration Co. Ltd. of London, and began what proved to be a lifetime of mine examination work throughout the world. Among the properties and companies with which he was associated are Broken Hill, South Australia; Ymir Gold Mines Ltd.; North Butte Copper Co. (later bought by Anaconda Copper Co.); Calumet & Arizona Copper Co. (which through a merger with Copper Queen was the beginning of Phelps Dodge Corp.); and Greene Cananea Co., to name but a few. In recent years he had undertaken a comprehensive study of the tin mining industry in Mexico, an extensive study of California's gold mother lode, and in Arizona, a study of the Standard Copper mine. He was also active in inspection of uranium prospects in the U.S. and Canada and made several mine examinations in Cuba. In 1958 he was active in investigation work in Ecuador, in the Lake Chibougaman district of Canada, and in New Mexico and Nevada.

Thomas Cox (Legion of Honor Member, 1901) died March 14. 1961 at the age of 97 in an Oakland, Calif. rest home. He was a native of England and received his education there. He began his professional career in the gold mines of Montana in 1883 and became widely known in mining circles in 1906 when he designed a smelter plant built by the Nevada Consolidated Copper Co. at Ely, Nev. In 1907, Cerro de Pasco Copper Co. engaged him to supervise the construction of a smelter at La Fundicion, Peru. During the first World War, Mr. Cox served as director of the oil division of the Federal Fuel Administration. After the war he was employed as a consulting engineer by several oil companies. He retired in 1926, but was lured into state service five years later to become first assistant to Charles Purcell. chief engineer for the San Francisco Bay Bridge.

Lloyd E. Daume (member 1955) died March 3, 1961. He was born Oct. 18, 1903 at Laurium, Mich. and received his professional education at the Michigan College of Mines. He attended the College intermittently for 6½ years, and worked as stake man, rod man, topographer, etc., for various state Highway Departments and the U.S. Department of Public Roads. Other experience at the time included work as resident engineer, railway construction, Calumet & Hecla Consolidated Copper Co.; various mining jobs in Utah and Arizona on lead and copper to learn operations and processes; chief engineer and mine foreman, San Francisco Mines of Mexico Ltd.; and engineer in charge of exploration in Lower

(Continued on page 636)

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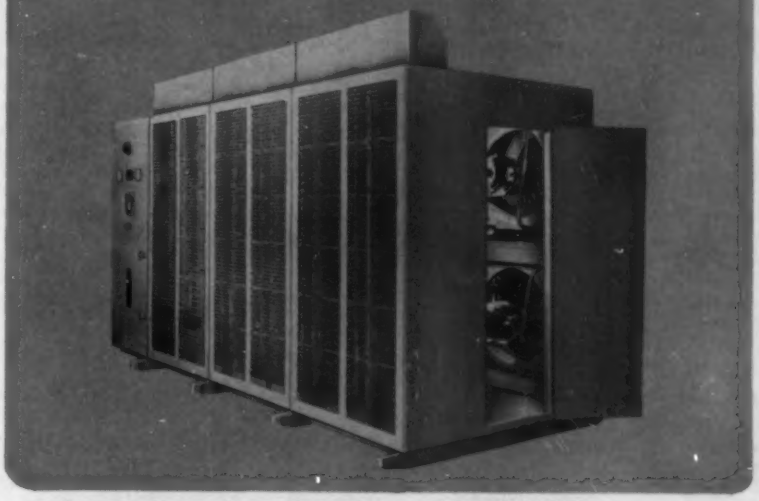

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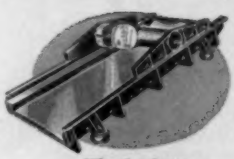

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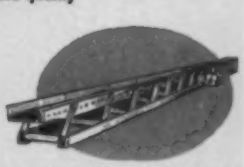

Mechanical Vibrating Conveyors

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Obituaries

(Continued from page 635)

California for the same company. After completing his college work, Mr. Daume began his association with Bolivian mining interests which was to continue throughout his life. He began as chief engineer for Patino Mines & Enterprises Consolidated Ltd. From 1935 to 1948 he served as general manager, vice president, and director of tin, antimony, lead-zinc-silver-copper-gold, tin-silver, and tin-tungsten mines in Boliva. From 1948 he served as consulting engineer, managing director, and director of various mining companies controlled by the same principals (including S. I. Patino Suc., Southern Minerals Ltd., and Rhodesia Copper Ventures Ltd.) in Bolivia, Brazil, and Africa.

R. W. Gordon (Member 1905) a native of Scotland, died recently in Denver, where he had resided for many years. He began his mining career in British Columbia in 1897. He came to the U.S. in 1900 to prospect for copper in Arizona. At the time he became a member of AIME he was with General Metals Co., Colorado Springs, Colo. Before his retirement in the early 1950's he was Deputy Regional Director, WPB.

James C. Johnston (Member 1941) died recently in Marmet, W. Va. He was born in Chicago on July 26, 1900 and was a graduate of Ohio State University. He began his career as resident engineer for Pike-Floyd Coal Co. in Kentucky and was associated with the coal industry throughout his life. For well over the past decade he had been associated with Eastern Gas and Fuel Associates.

Esper S. Larsen (Member 1927) died March 8, 1961, a few days before his 82nd birthday. He was born in Astoria, Ore., and received his education at the University of California. After graduation he went to work as assistant petrographer at the Geophysical Laboratory in Washington, D.C. In 1909 he went with USGS as geological aid and geologist and remained on the staff for 14 years. In 1927 he became professor of petrology at Harvard University, continuing in that post until the early 1950's. He then returned to Washington, D.C. as consultant to USGS. He retired around 1955 but continued to make his home in Washington.

Charles H. Matthews (Member 1924) died Dec. 11, 1960 at the age of 77. He was born in Buffalo, N.Y. and attended Ohio University where he graduated as an electrical engineer. His first connection with the mining industry was while he was associated with Jeffrey Mfg. Co., where he assembled and tested mine locomotives and coal cutters and later worked on the mechanical design of mining equipment. From 1910 to 1918 he was with General Electric Co. and during part of that period was application engineer on apparatus for mining service. From 1914 to 1918 he was sales representative in the iron and copper districts of Minnesota, Michigan, and Wisconsin. Other companies with which he was associated include W. A. Hanna Co., Hudson Coal Co., and Westinghouse Electric & Mfg. Co. where he was head of the mining section.

Edward LeMaire (Member 1951) was killed in a plane crash in Brussels this February. He was born in New Rochelle, N. Y. on Oct. 26, 1924. He attended Yale University for a year before entering the Navy as an aviation cadet, returning to Yale in 1946. He later attended the University of Nevada and University of Pittsburgh. He was sales-service engineer for Crucible Steel Co. of America after leaving school. At the time of his death he was a broker with Adams & Peck.

Fred H. Minard (Legion of Honor Member 1897) died recently at the age of 89. He was born in Kansas and received his education at the University of Chicago. His examination and operations of mines, and consulting practice took him to Europe, Central and South America. He had made his home in Los Angeles for many years after he had retired.

Miles S. Milward (Member 1914) died recently in Berkeley, Calif. He was born in Cape Town, South Africa in 1883 and received his education in private schools in England and various parts of the U.S. He began his mining career as a public assayer with Gorrill, Milward & Gorrill in Nevada in 1905. Over the years he was associated with several mining companies in Mexico. Between his Mexican assignments, he carried on operations in California.

G. R. Spindler (Member 1940) died Feb. 20, 1961 in Morgantown, W. Va. His entire life was associated with his native state. He was born in Terra Alta, W. Va. on Nov. 27, 1902, was educated at West Virginia University, and at the time of his death was dean of its School of Mines. He had been on the University's staff since 1934. He had been a partner in the Spindler Coal Co. and an engineer for Pittsburgh Coal Co.

Ronald L. Terrill (Member 1957) died recently at the age of 23. He was born in Idaho Falls, Idaho and graduated from the University of Idaho in 1960 as a geological engineer.

Paul W. Kruse (Member 1946) died Feb. 20, 1961 at the age of 64. He was district superintendent, Eastern District, Jones & Laughlin Steel Co., Minnesota Ore Div., at the time of his death. Mr. Kruse was born in Ishpeming, Mich. He attended St. Thomas College, University of Toulouse, and University of Michigan. Since 1922 he worked in the Michigan and Minnesota iron district as surveyor, engineer, ore inspector, and mine superintendent for Inter State Iron Co., before becoming associated with Jones & Laughlin Steel Co.

Necrology

Date Elected	Name	Date of Death
1952	R. F. Aldredge	Unknown
1919	H. L. Alling	July 1960
1897	R. M. Atwater, Jr. (Legion of Honor)	March 1961
1927	Bert C. Austin	Unknown
1956	R. Peter Bannister	Feb. 11, 1961
1952	W. B. Brubaker	May 1960
1904	R. H. Channing (Legion of Honor)	April 1, 1961
1945	C. H. Corbin	June 1960
1956	R. O. Corley	Nov. 13, 1959
1931	John Paul Dyer	Mar. 19, 1961
1957	H. L. Farling	Sept. 26, 1960
1955	Max C. Farmer	Dec. 12, 1959
1959	Joseph Garnero	July 1960
1918	H. A. Geisendorfer	Sept. 21, 1960
1918	G. C. Gester	Nov. 24, 1960
1949	Geo. T. Gillison	Unknown
1933	Lloyd L. Gray	June 1960
1937	W. E. Hobson	Unknown
1956	Claude L. Holloway	Mar. 23, 1961
1954	John B. Janney	July 15, 1960
1958	Robert T. Ketcham	Dec. 4, 1960
1916	Kuo C. Li	Mar. 7, 1961
1947	J. A. Retty	Mar. 14, 1961
1931	Arthur J. Rice	Mar. 31, 1961
1913	Sidney Rolle	Mar. 25, 1961
1900	W. Selkirk (Legion of Honor)	Feb. 16, 1961
1959	Harold E. Taylor	Nov. 1960
1920	C. W. Tomlinson	Apr. 3, 1960
1920	R. A. Tregonong	Nov. 10, 1960
1943	Norman E. Thompson	Feb. 18, 1960

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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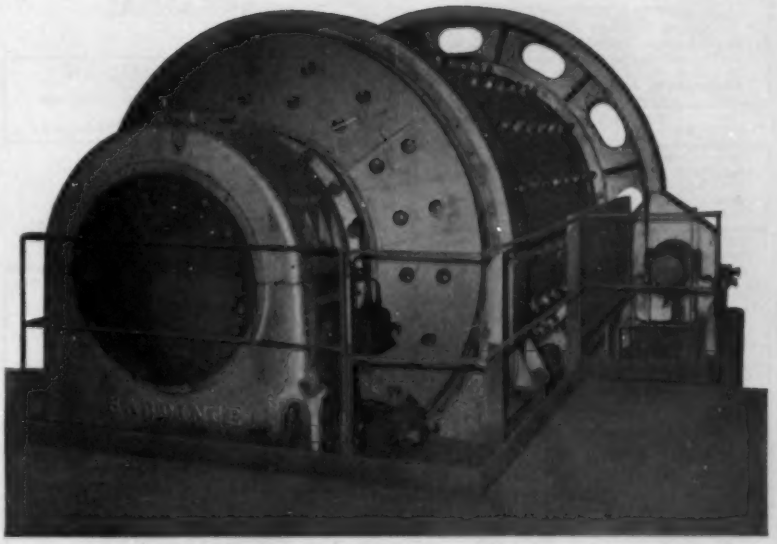

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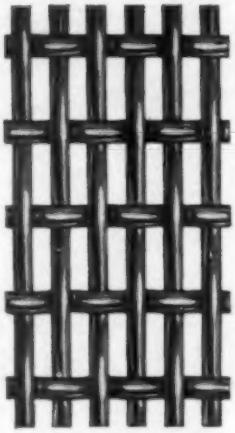

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